The FOUNDRY

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Castings Help To Test the Purity of Milk

AS CIVILIZATION progressed, man has learned to protect himself from disease by watching the handling of foods. The crusading spirit of a few pioneers has awakened people to the necessity of pure foods and has resulted in laws aimed at protection. Milk, being one of the important foods, requires most careful and complete supervision in its various steps from the farm to the consumer. Tests are made all along the line to catch the appearance of harmful bacteria. To carry on this work properly, the larger dairies, and also many of the smaller ones, maintain laboratories where the milk is tested as it is received from the various sources of supply. The accompanying illustration shows the interior of a milk laboratory. Much of the equipment used to conduct the required tests, contains castings. The separator in the center of the illustration contains castings as does the pressure vessels shown at the left. Castings aid in maintaining the high degree of purity required in the preparation of milk and other dairy products for the market.

Milk Must Be Marketed with a Prescribed Percentage of Butter Fat and Must Be Free from Harmful Bacteria. Castings Are Used in Much of the Apparatus for Testing

Courtesy Telling Belle Vernon Co., Cleveland

Find Where Castings Can Be Sold

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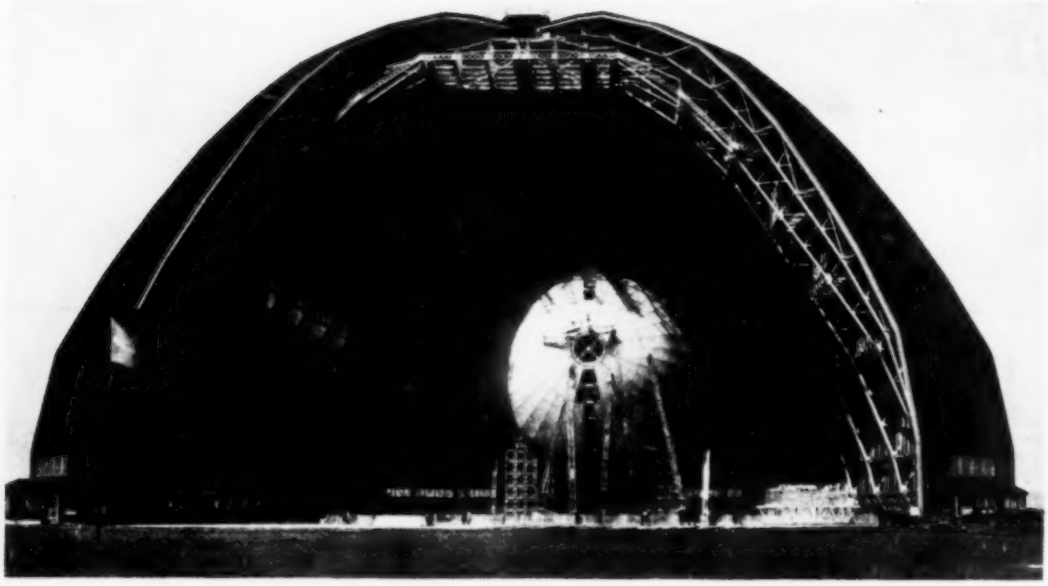


Fig. 1—Two Orange Peel Doors Swinging on a Pivot At the top and Mounted on Trucks Swing To Either Side To Expose the Full Width of the Hangar

Navy Completes U.S.S. AKRON

DIMENSIONAL figures of large objects convey at best but a confused idea to the mind of any person who has had no practical experience in the application of figures in this manner. He needs some other unit of measurement and when that is supplied he can form a mental comparison that is fairly satisfactory. Tell the average man that the ZRS-4, the U. S. S. AKRON, just completed by the Goodyear-Zeppelin Corp., Akron, O., for the United States navy, is 785 feet in length and has a maximum diameter of 132.9 feet, and the chances are that this mental image is not accurate to within 100 feet in the length or to within 25 or 30 feet in the diameter. Any man familiar with seagoing ships can conjure up a mental vision of this giant of the air by comparing her dimensions with those of the AQUITANIA and the MAURETANIA. The ZRS-4 is 5 feet less in length than the MAURETANIA and 116 feet less than the AQUITANIA.

People living in the vicinity of the Great Lakes have seen the fleets of bulk freighters that ply these inland seas. The two largest of these boats, the CARL BRADLEY and HARRY COULBY, 638 and 630 feet in length respectively are 147 and 155 feet less in length than the new air ship.

To secure a proper impression of the extent and magnitude of this awe inspiring craft one should do as thousands of visitors have been doing daily, and that is walk into the dock and gaze up at the huge pointed cylinder as it rests easily in its elevated cradle. Millions of people have seen the British R-100, the LOS ANGELES and the GRAF ZEPPELIN. The new ship is greater than any of these, 76 feet longer than the

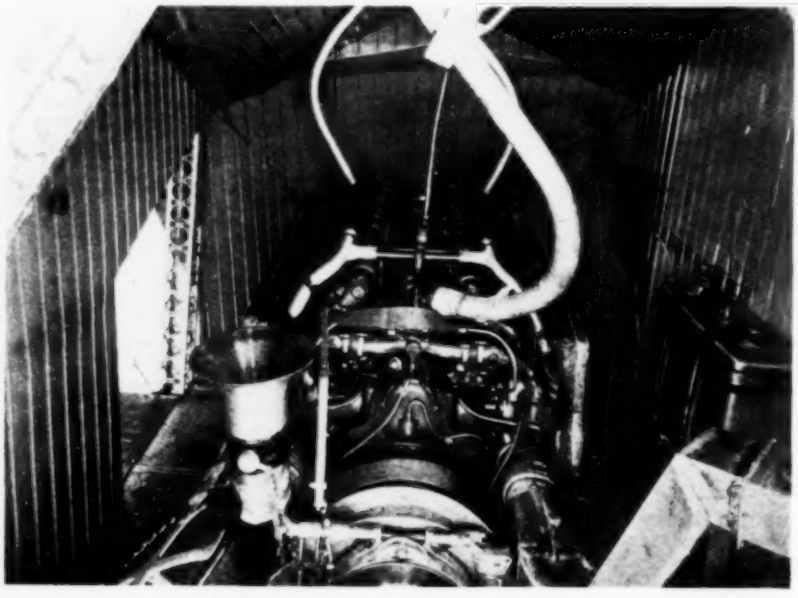


Fig. 2—General View of One of the Eight Engines As It Appeared When Set up for a Test Under Operating Conditions

R-100, 127 feet longer than the LOS ANGELES and 9 feet longer than the GRAF ZEPPELIN.

The accompanying tables present a comprehensive digest of all the principal features including the gross lift, 200 tons, and the weight that may be carried as cargo, 91 tons. These two items perhaps more than any other, when considered in connection with the length and diameter, serve to emphasize the difference between air and water craft. Briefly the ship is a huge inflated gas bag to which rigidity has been imparted by a fabricated aluminum frame, which is light but strong.

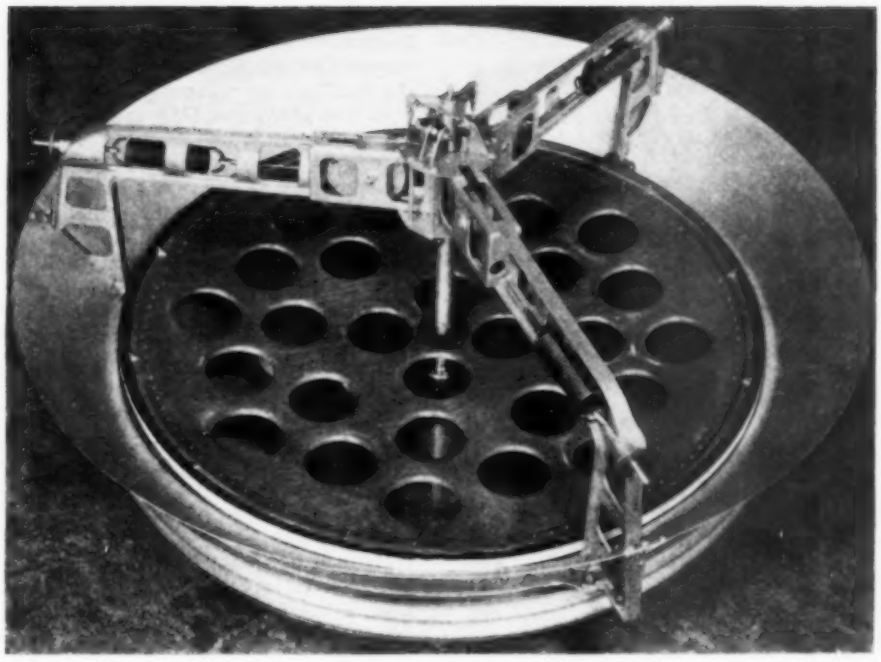


Fig. 4—One of the Eight Automatically Operated Relief or Blowoff Valves, One of the Mechanisms in Which Castings Are Used

Castings used in the ship include various component parts of the eight 12-cylinder engines which were built in Germany, relief or blowoff valves 32 inches in diameter, for which the castings were supplied by the Aluminum Co., of America, also various castings for water valves, pumps and other accessories. Mechanism for operating the doors of the dock, large cast steel frames and gearing was designed by the Wellman Engineering Co., Cleveland.

The dock in which the AKRON was constructed, at Akron airport two miles from the Goodyear factory, half a mile from the Goodyear-Zeppelin shops, is the largest and perhaps the most unusual building of its kind to be found any place in the world.

As a piece of engineering it is little less inter-

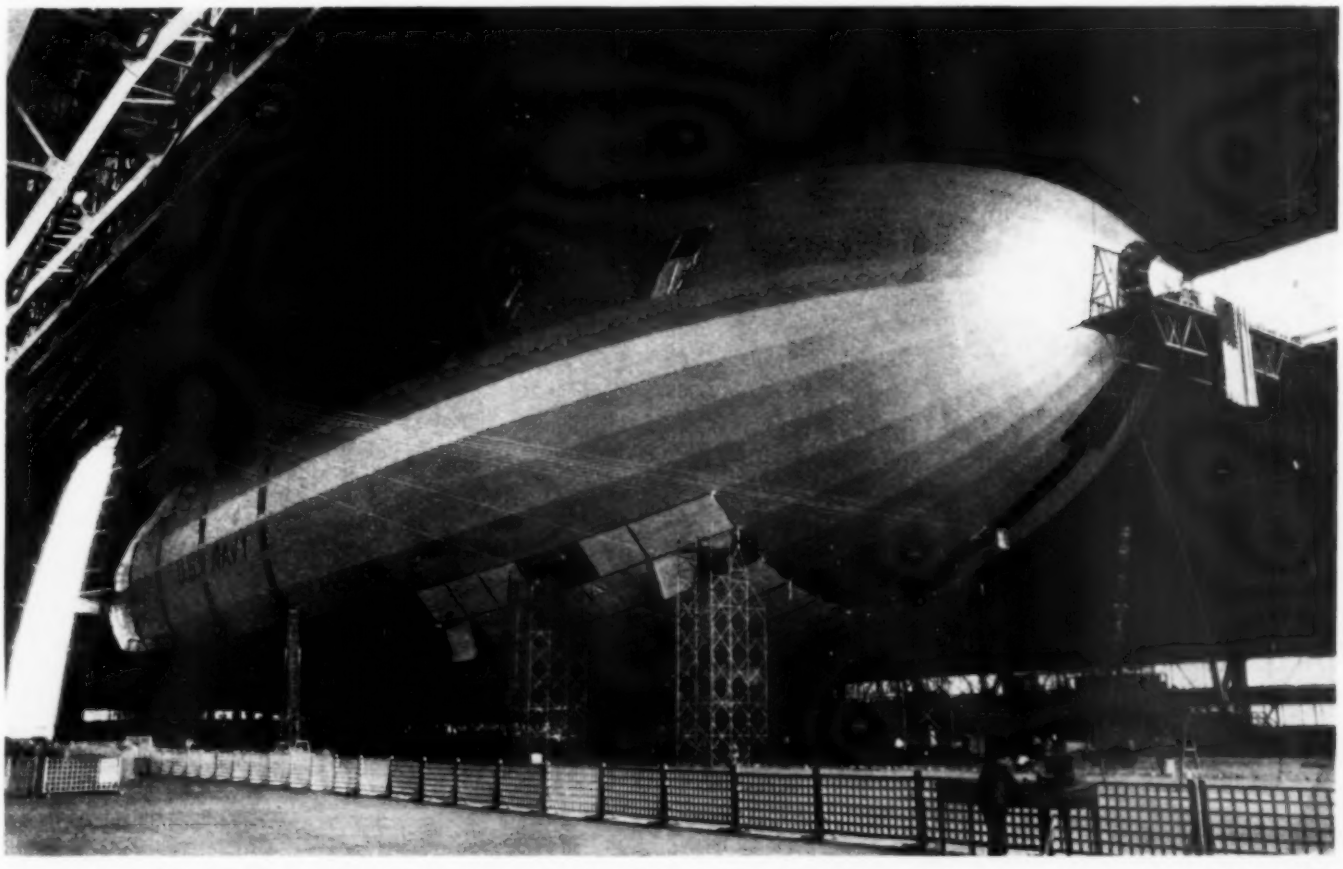


Fig. 3—The Z R S 4, otherwise the U. S. S. Akron just completed by the Goodyear-Zeppelin Corp., Akron, O., for the United States Navy Is 785 Feet in Length and 132.9 Feet in Diameter

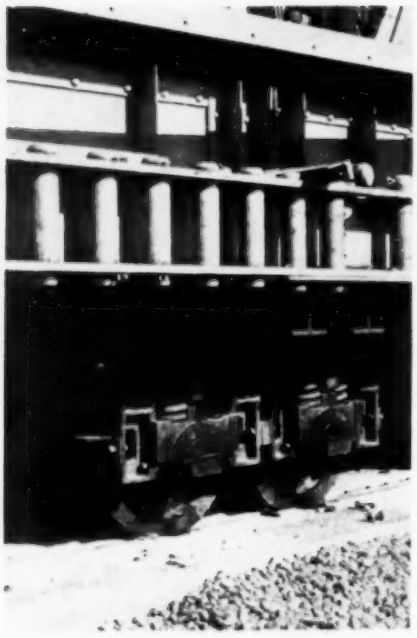


Fig. 5—Closeup of the Rack and Trucks on Which One of the Hangar Doors Is Mounted

esting than the airships being built under its massive dome, and so has attracted hundreds of thousands of visitors.

The orange-peel-shaped doors, weighing 600 tons each, follow the contour of the building in opening and closing and are attached to a single six-foot pin at the top and roll on 40 wheels, assembled on four-wheel trucks, riding on a circular track.

The doors must be under control at all times. A rack drive system was devised, with a large bull gear mounted on a fixed concrete base outside the building at each corner. The gear engages a rack attached rigidly to the door itself. Thus, as the motor revolves the bull gear turns slowly and the rack is driven back and forth, pushing the door with it. The doors can be driven at a speed of 40 feet per minute, but automatically slow down to a creeping speed as the doors come to wide open or closed position. Stops are automatic.

The building is 1175 feet long, 325 feet wide, and 211 feet high, the largest structure in the world without interior support. Ten football games could be played simultaneously under its roof, six miles of standard railroad tracks could be laid on its eight and one-half acres of floor, 100,000 people could gather within its walls, the LEXINGTON and SARATOGA, the great airplane carriers, could be housed there, the Woolworth building could be laid lengthwise inside and the Washington monument added alongside.

Tunnels have been built under the concrete floors for service facilities and for the docking rails, which will be used for moving the ships in and out of the structure. All service facilities, power, light, water, helium gas are brought into the building underground from outside sources of supply.

Since the 7200 tons of steel in the framework expand and contract with changes in temperature, the arches of the building are placed on rollers, so that the giant building may be said literally to breathe. Several working platforms, lowered from the roof, give the workmen access to the ship; and a series of six catwalks along the under side of the curving roof make the upper reaches accessible. An inclined railway, the cars being counterbalanced, carries the workmen to their stations aloft.

A helium storage plant was built underground, alongside the dock. Huge cylinders with a total capacity of more than 1,000,000 cubic feet of gas at 750 pounds pressure, were utilized. The gas will be drawn by suction from storage tanks to gas cells or vice versa at the rate of 1,000,000 cubic feet in 24 hours, or can be removed at a somewhat slower rate for purification. The building cost close to $2,225,000 and required 11 months to build.

Every Zeppelin ship has a metal keel or backbone, as part of its strength to resist the effect of thrusts of the wind. The AKRON has three such keels instead of one. Each keel airship is large enough to contain a corridor or gangway running from one end of the ship to the other, giving accesibility throughout the ship, offering space alongside for fuel, ballast, passenger or crew quarters, baggage and mail compartments. By placing one of these corridors or backbones at the top of the ship and the other two at 45 degrees from the bottom, the accessibility to service facilities and for maintenance are increased.

In the AKRON all the helium release valves, automatic and manual, are placed at the top. The valves are installed along the top keel or corridor so that the commander may be sure at all times they are in perfect working order.

The Goodyear-Zeppelin Corporation evolved a new type of main ring or frame of triangular cross section. Each is built inherently strong, without the great network of wiring used in previous types. A spider web of wire netting is used between gas cells merely to hold them in place and designed so that they cannot catch in the cell or chafe against it.

Strengthening of the ship permitted another improvement. Up to 1924 most control cars and all power cars were suspended on struts and wires outside the body of the ship. Early ships usually had one engine mounted in the after end of the control car. Since all ships were hydrogen-inflated, it was necessary to get complete ventilation, to prevent the possibility of sparks from the motors coming in contact with the lifting gas.

In the LOS ANGELES, the engine was omitted from the control car and given a separate gondola, and the con-

Air Ship Dock Items

Length, center to center end doors, 1175 feet.
Width, center to center hinges, 325 feet.
Height, center to center hinges, 197 feet, 6 inches.
Total floor to platform 211 feet.
Interior floor area, 364,000 square feet.
Cubical content, 55,000,000 cubic feet.
Perimeter of arch, 562 feet.
Area of roof, 693,000 square feet.
Vertical sash, 28,000 square feet.
Skylights, 23,000 square feet.
Ventilators, eight at 6-foot diameter.
Airplane doors, 1580 square feet.
Metal doors, 2612 square feet.
Inlet louvres, 1600 square feet.
Piling, 1300 about 25 feet long.
Concrete foundations, etc., 8000 cubic yards.
Concrete floors, 7000 cubic yards.
Reinforcing steel 700 tons.
Structural steel in shell and shops, etc., 5500 tons.
Structural steel in doors, 1900 tons.

Fig. 6—The Hanger 1175 Feet Long, 325 Feet Wide and 211 Feet High, Is Claimed To Be the Largest Structure in the World Without Interior Support

trol car was built integrally into the hull of the ship. The AKRON takes the next step forward and for the first time in history, places the engines inside the ship. The cutting down of resistance is obvious. Also the cramped quarters of power cars which were made as small as possible to cut down air resistance, give way in the new ships to comfortable engine rooms.

With hydrogen ships, past practice had been to release lifting gas from time to time to compensate for the steadily increasing weight of the ship due to the consumption of gasoline fuel. With the subsequent use of helium in airships and the need of conserving it, means of recovering water from the exhaust of the engines by exhaust condensers was introduced. This is therefore a means of preserving static balance of the ship without the need of valving gas, as gasoline is used weight of water recovered nearly equals the weight of fuel burned.

The condensers added somewhat to the parasitical resistance. A condenser system was devised composed of small ribbed fins along the side of the ship, something like the louvres in the hood of any automobile, getting a maximum cooling result with minimum resistance.

The fifth improvement brought out in the AKRON is the device of swiveling propellers. These can be swung in a 90-degree arc, and since the engines are reversible, give the ship vertical thrust, down or up. The swiveling feature will be valuable in maneuvering the ship, especially in landings and take-offs. Pointed downward to exert a vertical thrust this will enable a ship to take off heavy, carrying additional fuel and so increasing the cruising radius. They can be used also to drive the ship downward if it comes in for landing light, due to atmospheric conditions or other causes.

A storage hangar 60 x 75 feet in size, located about one-third of the ship's length from the nose has space for 5 airplanes. Planes may be released through a T-shaped opening in the ship's bottom by a trapeze arrangement ,while the ship is in flight. They may be picked up again on the trapeze, and hauled into the compartment by a winch.

At the eastern edge of the city of Akron, with a quarter million inhabitants, but within the corporation limits and three miles from the center of town, is the municipal airport of 900 acres, lying at an elevation of 1040 feet above the sea level in a natural basin flanked on two sides by low hills, unusually free from fog—a great level tract out of which rise the impressive arches of the Goodyear-Zeppelin Dock.

W. J. Austin, president, the Austin Co., Cleveland, addressed the production conference of the American Management association held in Rochester, N. Y., recently.

International Congress Program Outlined

Plans for the International Foundrymen's congress to be held in Italy, Sept. 12 to 27, have been announced. The program is extensive and includes a schedule of meetings, sightseeing trips to points of interest and a plant visitation program to industries in many industrial centers throughout Italy.

The congress will be opened in Milan on Sept. 12. Meetings also are scheduled for the mornings of Sept. 13, 14, 15 and 16. The afternoons of those days will be available for visits to the exhibition, held in conjunction with the congress, and to sightseeing trips in and around Milan. During the stay in Milan, sightseeing trips to the S. Siro race course, Certosa of Pavia, Tremezzo, Villa Carlotta, St. Vincent, Aosta and Chivasso, are planned.

Upon leaving Milan, the group attending the convention will be divided into two parties, designated as parties A and B. Party A will visit Cogne, Aosta, Turin, Genoa, Cogoleto, Savona, Vado Ligure, Rome, Terni, Perugia, Todi, Orvieto, Viterbo. Party B will visit Pre St. Didier, Little San Bernardo, Courmayeur, Aosta, Genoa, St. Vincent, Ivrea, Turin, Santa Margherita, Zoagl, Rome, Terni, Spoleto, Assisi, Perugia, Todi, Orvieto, Viterbo.

The final meeting of the congress will be held in the Campidoglio, Rome. A reception also will be held during the stay in Rome, under the auspices of the Confederazione Generale Fascista dell' Industria Italiana.

Crane Companies Merge

Euclid Crane & Hoist Co., Euclid, O., and the Armington Engineering Co. have approved a plan of consolidation whereby the manufacturing and engineering facilities of the two companies are combined in the Euclid Crane & Hoist Co.

The name of the company has been changed to the Euclid-Armington Corp. A complete line of hand and electric power cranes is produced, including mill-type cranes up to 100 tons capacity. The company also manufactures electric hoists, trolleys, winches, cupola chargers, ladle trolleys, etc.

ChroniclesAchievements

Enamel & Heating Products Ltd., which operates plants at Sackville, N. B., Amherst, N. S., and Victoria, B. C., has issued a bulletin describing and illustrating the achievements of the company. The bulletin is entitled, "A Chronicle of Achievement," and was written by Percy N. Woodley. Included in its contents are descriptions of the various plants, biographies of officers and founders, and descriptions of the manufacturing processes. The latter section of the bulletin is devoted to historical sketches of the mythological origin of bath room and heating fixtures, illustrations of the products made by the various plants, and reproductions from photographs of installations throughout Canada.

Airship Facts and Figures

	Akron	Los Angeles	Graf Zeppelin	R-100
Nominal gas volume, cubic feet	6,500,000	2,470,000	3,700,000	5,000,000
Length overall, feet	785	658.3	776	724
Maximum diameter, feet	132.9	90.7	100	132
Height overall, feet	146.5	104.4	113	140
Gross lift, pounds	403,000	153,000	258,000	341,000
Useful lift, pounds	182,000	60,000	.....	.....
Number of engines	8	5	5	5
Total horsepower	4,480	2,000	2,750	3,000
Maximum speed, miles per hour	84	73	80	70
Range at 50 m.p.h., cruising speed without refueling, miles	10,580	4,000	6,125	4,200

Hold Golf Tourney

Detroit Foundrymen's association held its second summer golf tournament July 31, at the Plum Hollow Golf club. C. H. Miller, Standard Pattern Works, Detroit, is chairman of the golf committee. More than 60 attended the tournament.

Wins Bronze Trophy

During the past 6 months, 79 plants in and around Baltimore have been competing in a safety campaign sponsored by the Baltimore Safety council. Black & Decker Mfg. Co., Towson, Md., was the winner of the bronze trophy. That company had no lost time accidents during the campaign.

F. C. Butman has been appointed district manager of the Western New York territory for the Dispatch Oven Co., Minneapolis. Mr. Butman formerly was connected with the Dispatch Oven company but has been on a leave of absence to act as efficiency engineer, Roneo Ltd., Romford, England.

Research Improves Quality of ELECTRIC STEEL

By F. A. Melmoth

IT WOULD seem logical to expect that steels of equivalent composition, made in each case in acid-lined furnaces, and under slags of fairly comparable types, would possess the same characteristics, irrespective of the method of heat application to the furnace. However over a period of many years, the author has encountered conflicting views on the subject from a variety of sources. It is not uncommon, for instance, to meet with the expressed opinion of practical foundry foremen that electric steel gives more trouble, than the acid open-hearth variety, particularly with reference to hot-crackng. On the other hand, purchasers of castings often are encountered who have a rigid preference for one or the other, but such opinions are varied.

Investigates Relative Properties

Since there appeared to be practical value in an investigation into the relative properties, and the characteristics of behavior, of similar steels made by the two process, it was decided to compare, physically and microscopically, steels of close chemical composition, and identical heat-treatment. The object of this step was to disclose any possible variation in the latent capacity of the two materials to respond to more advanced heat treatment.

Any variations in the cast structures likely to exert an influence on the practical performance of the two steels in the foundry also was studied. The response of the two steels to heat treatment, from the point of view of time taken to produce equivalent conditions of microstructure, at identical temperatures was undertaken. Assuming the confirmation of any suggested variation was acertained, it also was decided to study comparative conditions in the furnaces with a view to explaining the controlling causes.

Six test blocks of electric steel and six of open-hearth steel were cast into dry sand molds of identical size and shape from normally worked charges of steel. These two sets of blocks were shaken out after they were solidified, and allowed to cool in air. Their chemical composition is given in Table I.

The schedule of treatments for each block was as shown in Table II. The bars were treated in pairs in an electric, automatically-controlled furnace, one electric and one open-hearth bar constituting each pair. The results obtained from bars turned to 0.505 inch diameter are shown in Table III and IV. As a check on the results obtained six other bars of identical shape and size were cast from each type of steel, and, in this case, were allowed to cool to atmospheric temperature in the sand before shaking out. The analysis of these bars also is shown in Table I.

The test results of these six pairs of bars, after identical heat treatments are shown in Tables III and IV.

Fredrick A. Melmoth

Studies Practice

CONVINCED that there was some explanation for certain abnormalities in electric furnace steel, the author decided to investigate the causes. Accordingly, a series of test bars were cast from an acid open-hearth steel heat and another series from steel manufactured in the electric furnace. The bars were subjected to various heat treatments and the results obtained are given in the article, which is abstracted from a paper presented by the author at the recent Chicago meeting of the American Foundrymen's association. At the same time that the responsiveness of the two differently manufactured steels to heat treatment was investigated, research was undertaken on furnace practice. Results which are given in the article, when applied to the electric furnace, produced a superior steel than had been made before the investigation. The author is assistant manager, Detroit Steel Casting Co., Detroit.

Quality Formula Used

As some true indication of the comparative quality of the steel in varying conditions was desired which would give full effect to all the factors constituting the tensile test, it was decided to utilize a formula used and recommended by J. Kent Smith. This formula gives an indicative figure which may be accepted as a true reflection of the combined properties shown by the orthodox tensile test. The formula is as follows:

$$\text{Factor} = \frac{\frac{X + Y \times Z}{2}}{100 - W}$$

X = Yield point in pounds per square inch
Y = Maximum stress in pounds per square inch
Z = Elongation, per cent in 2 inches
W = Reduction in Area, per cent

In the cast condition, the open-hearth and electric material practically are identical in tensile strength, yield point, elongation and reduction. The quality factors are: Electric, 12,650; open-hearth, 14,180. When the steels were subjected to the second treatment shown in Table II the electric steel appears to have been influenced to a greater extent than the open-hearth material, as far as tensile strength and yield point are concerned. The resulting elongation and reduction of area figures are improved considerably in the open-hearth steel. Quality factors are: Electric, 22,020; open-hearth, 34,900. Both steels were affected somewhat adversely by the prolonged soaking at 1650 degrees Fahr. in the third treatment. The quality factors shown are: Electric 18,660; open-hearth, 27,950. The fourth condi-

tion is representative of what might be expected from the usual annealing practice of fairly heavy castings, followed by slow cooling. As might be expected, both tensile strength and yield point are reduced somewhat, but this is accompanied by a sharp improvement in elongation and reduction of area. Quality factors found are: Electric, 30,946; open-hearth, 34,904.

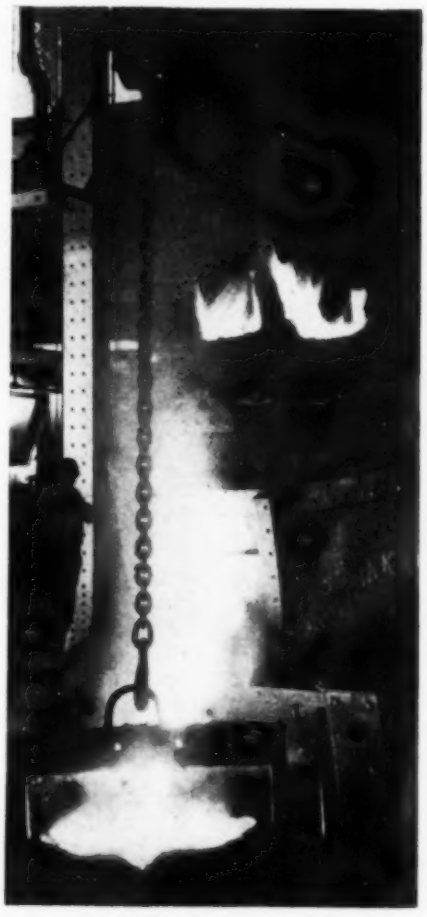
Quenching has a marked influence on the tensile and yield points of both materials as shown in treatment five. The fall in elongation in the open-hearth sample badly lowers the quality factor, although it is accompanied by remarkably high reduction of area, namely, 63.5 per cent. Quality factors for the two steels are: Electric, 43,683; open-hearth, 40,000. The lower draw temperature used in the sixth method of treatment has caused an appreciable increase in yield point and maximum strength in both samples. With these higher tenacity figures, the ductility properties have decreased, particularly in the case of the electric steel samples. This would indicate that the limit of strength plus reasonable ductility is reached sooner in this electric sample. It also suggests that it is unwise to force a fixed composition to its strength limit of performance by low draw temperatures following a quench, and that a higher carbon content, drawn at a higher temperature, would result in a greater degree of combined strength and ductility. Quality factors are: Electric, 22,100; open-hearth, 31,900. The average performance of each steel in the six condtions is: Electric, 25,105; open-hearth, 30,639.

Furnace Practice Studied

During the time this experimental work was proceeding, a coincident investigation was carried out to find the controlling causes of certain occasional abnormalities of behavior of electric steel. These deviations from the normal appeared in the microstructure of the heat-treated steels as a definite tendency for the ferrite areas to arrange themselves in a straight-line formation, instead of in the usual rounded, evenly-disposed manner. The degree of development of this peculiarity appeared to exert a progressive deleterious influence on the test results obtainable.

The possible controlling causes of the presence of the abnormal structure might arise from one or more of the following: Higher temperature of casting in electric steel; the existence of nonmetallic impurities, probably ultramicroscopic, but predisposing the steel to certain formations due to their permanent location; some influence of intensely-localized high temperature during the manufacture of the steel, as the result of arc action, or some variation in working conditions between open-hearth and electric during the manufacture of the charge.

It was found definitely that, while high temperature of casting would affect the degree of the abnormality, yet its effect could be found at times in samples cast near the end of the pour, when the metal was distinctly cool. Several charges of electric steel were deliberately held for various periods of time ,under a good slag, when ready for tapping. It was considered that this would allow a more complete coagulation and levitation



Tapping a Heat of Steel from an Electric Furnace

to the slag of any possible nonmetallic material existing in a finely-divided form throughout the steel. Probably the worst case so far recorded of the abnormal structure was obtained in this way, after a holding period of 45 minutes. The test result on this material, after normalizing, was exceedingly poor. It was unusually low in elongation and reduction of area.

Connected with the consideration of the possible effect of nonmetallics is the question of the influence of deoxidizers. This is still under observation, but to date the author is of opinion that high silicon content or the use of aluminum has a decidedly aggravating effect on the condition. However, that they are not the cause is indicated by the fact that charges possessing normal silicon content, and in which no aluminum was used, have shown the abnormal structure tendency.

Since it is impossible to eliminate the arc effect, for obvious reasons, no data on this point is available. The fact that the degree of abnormality is so excessive as to deteriorate quality to a serious extent, only on occasional charges would appear practically to eliminate the idea of its being due primarily to arc effects.

To arrive at possible variations of manipulation and conditions in the electric and open-hearth steel manufacture, it is necessary to record each step of the process. Steel scrap plus a varying percentage of pig iron are used in open-hearth charges. The steel scrap is a mixture of foundry return scrap and foreign scrap, such as forgings, bar ends, etc. An electric furnace charge is composed of all steel scrap. The scrap is a mixture of foundry return scrap and purchased scrap of the dead-mild, sheet-clipping type.

Ore Used in Open Hearth

Carbon, silicon and manganese are on the high side, in an open-hearth charge when melted owing to use of pig iron. Unless the scrap material contains considerable iron oxide as rust, ore additions are required to oxidize silicon and manganese and to permit the bath to come to the boil for carbon removal. Electric furnace charges normally melt quite low in carbon, silicon or manganese, unless high-carbon scrap is used. In many cases no ore is used to bring the carbon down to the desired figure. The bath often is wild with oxide when molten.

By the addition of controlled quantities of iron ore or limestone, the required reactions to reduce carbon to the desired point are maintained in the open-hearth furnace. No excessive oxide at any point is permitted, and during the *boiling-down* period the temperature of the bath is built up and slag conditions brought under control. This means that the three factors of temperature, slag condition and carbon content, all are converging to the desired carbon content. At this point the slag should be inactive comparatively and the temperature of the metal sufficient for tapping. In electric steel melting, when low-carbon scrap material only is used, the charge arrives at the melted condition low in carbon, silicon and manganese, and is wild. It is covered by a slag necessarily high in active oxide, and the temperature is low comparatively. In good practice the period between this point and pouring is devoted, to simultaneously raising the temperature and conditioning the slag. This period is short when compared with the same elapsed time in open-hearth practice.

The enormous heat available from the electric arc is a standing temptation to the quick raising of tempera-

Table I

Chemical Composition of Test Blocks

First Set

	C	Si	Mn	P	S
Six Electric Steel Bars	0.24	0.34	0.77	0.015	0.028
Six Open-Hearth Steel Bars	0.24	0.28	0.75	0.038	0.035
Second Set					
Six Electric Steel Bars	0.21	0.35	0.66	0.036	0.035
Six Open-Hearth Steel Bars	0.27	0.34	0.66	0.033	0.045

ture, rapid finishing of the charge after melting and reliance upon deoxidizers to too great an extent, in the effort to compensate for lack of time.

A study of these relative conditions suggests three possibilities. The first is that the carbon content in the open hearth acts as a continual protective, and that the conditioning of the slag is the result of a mutual effect between slag and the underlying metal.

Three Conditions Possible

In the second place, the absence of this carbon content in the electric furnace demands bringing a third influence into action, if equally equilibric conditions between slag and metal are to be obtained before tapping. Commonly, this third influence is a deoxidizer such as silicon, which necessarily leaves behind it residual nonmetallics which may or may not be eliminated entirely. The silica so produced is extremely fine and it is unlikely that levitation to the slag occurs to any considerable degree.

The third possibility is that, in the locality of the arc, considerable reduction of silicon takes place from the slag, and that such atomic silicon probably is oxidized quickly by iron oxide contained in the molten bath of steel. This would result in the continuous formation of silica in an emulsified form in the steel.

The best proof of these tentative hypotheses would be a practical trial in which the electric furnace conditions are brought as nearly as possible to open hearth. Therefore, charges were made, deliberately designed to melt on the hard side, and the carbon content was lowered by the action of the slag. Simultaneously, of course, temperature was raised to the desired point and finishing and tapping performed in the usual manner. It was found that most charges, melting about 0.35 to 0.40 carbon, required little or no ore, but that a small amount of limestone was adequate to liberate sufficient free iron oxide from the slag to bring the carbon content to the percentage desired in the metal bath, 0.15 per cent.

It is safe to say that all charges so made and tested showed themselves of considerably superior quality. They were remarkably responsive to heat treatment, and compartively free from abnormal structure sometimes previously noted. However, they were not absolutely free from it in all cases.

As a result of those findings, a second set of comparison bars was made and the electric charge was manipulated in the manner suggested by the results of the trials. The results are extremely interesting.

The heat treatments on the second set of bars were carried out exactly to the schedule previously used for the first set of comparisons. The higher carbon content in the open-hearth bar naturally shows an effect on strength, but the use of the quality factor, as an index of the capacity of the material, nullifies this for the final consideration. The only variant, as compared with the first set of bars, was that the second set was allowed to cool to atmospheric temperatures without disturbance, to insure identical conditions.

Slow cooling in sand has lowered the tensile and yield point figures in the *as cast* condition, but has improved materially the ductility as shown by elongation and reduction of area. The electric furnace charge is particularly noteworthy, owing to the high reduction of area. Quality factors are: Electric, 23,550; open-hearth, 15,710.

The electric material has responded quickly to such a simple treatment as the second treatment shown in Table II and the figures are of a high standard. Quality factors are: Electric, 45,200; open-hearth, 25,500.

The increased soaking period under the third condition has had little ef-

Table III

Properties of Electric Steel Bars

(*Turned to* 0.505 *In. Diameter*)

First Set

	Bar Numbers					
	1	2	3	4	5	6
Max. Strength, lbs. per sq. in.	70,000	73,500	72,750	70,000	77,500	85,500
Yield Point, lbs. per sq. in.	40,500	48,750	47,500	41,500	58,500	61,500
Per Cent Elongation in 2 inches	19.5	24.0	22.0	31.0	30.0	21.0
Per Cent Reduction of Area	19.5	33.4	29.6	44.8	53.3	30.6
Second Set						
Max. Strength, lbs. per sq. in.	62,750	69,750	71,250	65,500	74,250	83,750
Yield Point, lbs. per sq. in.	34,750	45,500	45,000	40,000	55,750	61,750
Per Cent Elongation in 2 in.	26.0	33.5	36.0	36.0	30.5	26.0
Per Cent Reduction of Area	44.85	57.3	58.3	57.3	61.7	57.5

Bars treated as in Table II.

Table II

Schedule of Treatments for Test Blocks

Further treatment.	Pair No.*	Heated, degs. Fahr.	Held, hours
.....	1	As Cast	....
Cooled in air, no draw.	2	1650	¾
Cooled in air, no draw.	3	1650	4
Cooled in furnace.	4	1650	4
Quenched in water, drawn ¾ hour at 1200 degs. Fahr.	5	1650	¾
Quenched in water, drawn ¾ hour at 1000 degs. Fahr.	6	1650	¾

*Each pair consisted of one electric and one open-hearth bar.

fect, but it is noticeable that the electric sample is improved somewhat. It is of interest to compare this with the previous set of comparison bars, when it will be seen that in this condition the two open-hearth bars practically are identical in quality factor, while the second electric charge possesses a factor nearly three times that of the previous one. Quality factors are: Electric 50,200; open-hearth, 26,700.

While the fourth method of treatment has brought out the qualities of the open-hearth steel it is singular to note that the electric steel so treated has lost appreciably in tensile and yield point, without a corresponding improvement in ductility. This suggests that the steel apparently lends itself more to normalizing than prolonged annealing. Quality factors are: Electric, 44,550; open-hearth, 30,500. The low carbon of the electric charge, with its comparatively low manganese content, does not lend itself to the attainment of high tensile figures when quenched and drawn as in condition 5. The yield ratio and reduction of area are high. Quality factors are: Electric, 51,900; open-hearth, 32,800. As would be expected from the sixth treatment, the lower drawing temperature has resulted in much higher tensile and yield point figures, with some reduction of ductility, as shown by elongation and reduction of area. Quality factors are: Electric, 44,500; open-hearth, 37,700.

Averaging the quality factors from this set of bars, we have the following results: Electric, 43,317; open-hearth, 27,820. Comparing these with the results shown by the first set, they show an increase in the quality factor of electric steel of 18,000 points. The whole matter requires further research. So far, results check the improvement in test results found in these trials. It is interesting to note that careful observation of difficult castings liable to hot-cracking has indicated definitely a marked reduction in the hot-cracking trouble in the case of the more controlled electric steel.

Table IV

Properties of Open-hearth Bars

(Turned to 0.505 In. Diameter)

First Set

	1	2	3	4	5	6
Max. Strength, lbs. per sq. in.	71,000	71,500	71,500	70,000	80,000	89,000
Yield Point, lbs. per sq. in.	42,000	44,250	43,250	41,000	59,000	64,000
Per Cent Elongation in 2 in.	19.5	31.0	27.5	33.0	21.0	23.0
Per Cent Reduction of Area	22.3	48.58	43.4	48.0	63.5	44.85

Second Set

Max. Strength, lbs. per sq. in.	73,250	78,000	77,500	72,750	85,750	96,250
Yield Point, lbs. per sq. in.	37,500	49,500	50,500	45,750	60,250	69,000
Per Cent Elongation in 2 in.	21.5	25.5	27.0	34.0	23.5	19.5
Per Cent Reduction of Area	24.08	36.30	35.35	47.72	46.69	41.87

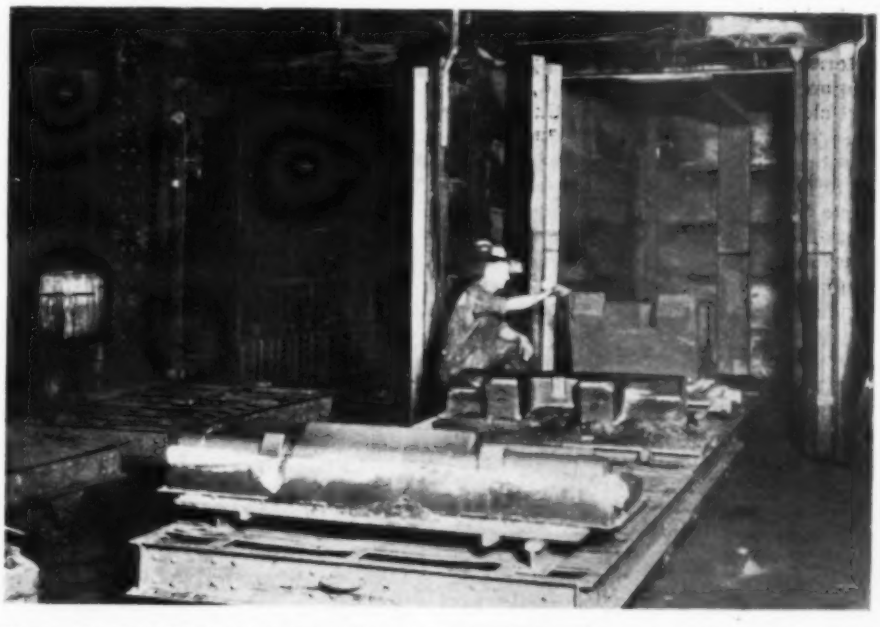
Bars Treated as in Table II.

Bakes Cores with Electric Heat

AN INTERESTING feature of the shops of the Norfolk & Western railroad, Roanoke, Va., is the use of electric heat for core baking. Three large electrically heated, core baking ovens are in operation in that shop, each of which is 8 feet 6 inches wide, 17 feet 6 inches long and 11 feet 6 inches high with an electrical capacity of 185 kilowatts and utilizing 3 phase, 60 cycle, 220 volt current. The ovens are truck operated, each oven holding two trucks, 6 feet wide, 8 feet long and weighing 9000 pounds. Most of the cores are large, such as those used for locomotive parts.

An average charge of cores per oven weighs 9000 pounds, and the power consumption is 800 kilowatt-hours per bake. At a cost of 8 mills per kilowatt-hour, the power cost is $6.40 per oven per bake, or $19.20 for the three ovens. The average value of the cores for the three ovens is $150 including labor and material, and for the steel castings annealed and sand blasted, $2000.

Since using electric heat in the ovens, an improvement has been reported in the castings. Blow holes, due to under baked cores, practically have been elimniated. Another source of defective castings, which has been overcome, was burned cores, resulting in the core flaking off or being washed away by the molten metal. Cores of the correct strength to withstand the eroding action of the molten metal are secured. At the same time, the cores are removed easily from the castings and are smooth and homogeneous. Loss due to improper baking has been eliminated practically and the castings have been improved.



Three Electrically Heated Core Ovens Are Used To Bake Cores in the Shops of the Norfolk & Western Railroad

Composition, Temperature, Time and Control Govern Short Anneal

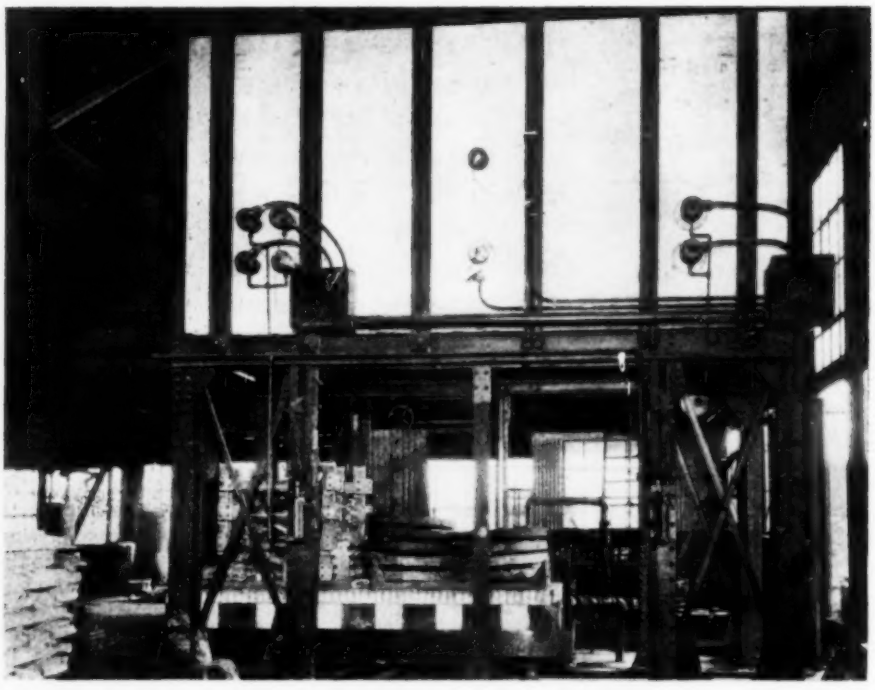


Fig. 1—Elevated, Electrically Heated Furnaces Are Used for Annealing. Castings Are Piled on the Car Which Forms the Bottom When Elevated into the Furnace

By Edwin Bremer

ALMOST from the time that the process of producing malleable cast iron was developed, there apparently has been a constant search for a method whereby the annealing period could be reduced. In the early days the art of making malleable cast iron was held as a valuable business secret, and there is little reference to the subject in literature of that time, except in a vague way. Simpson Boland, in an article on "Malleable Iron Castings" in THE FOUNDRY, April 10, 1894, quotes Claude Wylie's "Iron and Steel Founding" as follows: "A short time ago we visited a foundry in England where we were told they were making steel castings, and found the metal used to be old and burnt firebars of which they had an unlimited supply. These firebars were melted in an ordinary quick-melting cupola, the castings were made in ordinary green sand, and after the sand was removed from them, they were passed into an annealing furnace with a large proportion of hematite ore, and there brought to near melting heat—in fact, some of the boxes we noticed had a portion of them melted off; in three days they were ready for use. The old firebars remelted would be the most suitable metal for that purpose, containing no graphite carbon and little if any silicon. The castings we saw afterward were all that could be desired as malleable cast; they bent and chipped like malleable iron, but could not be welded."

In another place in the article Boland says "Long practice on the part of the furnaceman qualifies him for judging how long a time each casting requires for complete decarbonization; the heaviest are assigned to the hottest part of the furnace, marked in such a manner as will enable him to give each class a period of heat proportionate to the bulk.—The capacity of annealing furnaces varies somewhat, but they usually treat from 650 to 1200 pounds at one heat. The length of time required is from 2 days to 2 weeks according to bulk.—Usually the heat is gradually slackened for about 15 hours before taking out the boxes, and the latter are allowed to become cold before taking out the castings."

Flame Temperatures Differ

H. R. Stanford, in a paper presented at a meeting of the American Society of Civil Engineers in August, 1895, in discussing the use of oil fired annealing ovens, mentions that one oven using a smoky flame completed the annealing operation in 4½ days while another oven arranged as nearly identical as possible, and employing preheated atomizing air took 6½ days to anneal the iron farthest from the firehole. In speaking about the effect of sulphur on annealing time he states that couplers which analyzed 0.040 per cent sulphur and had sections 1½ inches thick, were annealed thoroughly in 3½ days, while iron bands for buggy wheels, which were no more than 3/16-inch thick and analyzed about 0.150 per cent in sulphur, were invariably hard if given less than 5 days.

Thus it may be seen that the novelty of annealing for a period considerably less than a week was not new 35 years ago. The late Dr. Richard Moldenke, speaking at the Milwaukee meeting of the American Foundrymen's association in 1903, mentioned even a shorter annealing period than those previously given. He said "In studying the annealing process we find two extremes leading to about the same results so far as carbon change is concerned. A short anneal at very high temperature is as effective as a comparatively long anneal at a much lower temperature. That is to say we can anneal, or rather change the carbon in a casting by placing it overnight in a melting furnace which has been let cool below the melting point of iron, or do the same thing in the annealing oven at a much

lower temperature but giving it a week's time."

While it is possible that many malleable foundries have used annealing cycles of less than 6 or 7 days, the first public mention of using 3 to 3½-day annealing cycles commercially was published in the June, 1908, issue of THE FOUNDRY which states in part "One of the heavy items of cost involved in the manufacture of malleable castings is the annealing expenses, and many devices have been tried by manufacturers in the past to reduce this charge, but all have proven unsuccessful. By methods pursued by the Allegheny Valley Malleable Iron Co. in its new plant, New Kensington, Pa., castings have been annealed successfully in 3½ days in a green oven, and later this time was reduced to 3 days. When subjected to the same tests given castings that remained longer in the anneal, they showed physical properties that compared favorably with the latter." The article includes an illustration showing several bars of different shapes before and after twisting tests, and mentions that notwithstanding the thickness of the castings, no fractures were developed. Crushed slag from the furnace skimmings was the only material used for packing.

Annealing Time Varies Greatly

Apparently there was considerable difference of opinion 20 years ago as to what constituted a good annealing cycle. According to W. P. Putnam in the October, 1911, issue of THE FOUNDRY, the time varied from 72 to 208 hours. In the article he goes on to say "To call attention to the variations in the quality of castings that can be produced during the annealing process, a number of test bars were made and sent to various malleable foundries to be annealed in accordance with their usual practice. The bars all were made of the same metal and to obtain castings free from shrinkage in the center, the ends were made large. In all the bars broken, but little draw was found. The analysis of the iron that that was used for the bars is as follows: Silicon, 0.74 per cent; sulphur 0.041 per cent; phosphorus, 0.148 per cent; manganese, 0.24 per cent, and combined carbon, 2.70 per cent. The chemical and physical properties of the annealed bars are shown in Table I.

"It will be noted that in each case where the bars were subjected to a long period of annealing or higher temperatures than necessary, the carbon was nearly all removed. Either practice is wasteful and will produce poor malleable iron. The annealing process should be conducted to produce definite results. Metal intended for parts to be machined should be treated differently in the annealing process than metal that is not machined. To find the correct annealing temperatures the critical and proper annealing temperatures were ascertained on a number of hard iron specimens ranging from 2.35 to 3 per cent total carbon.

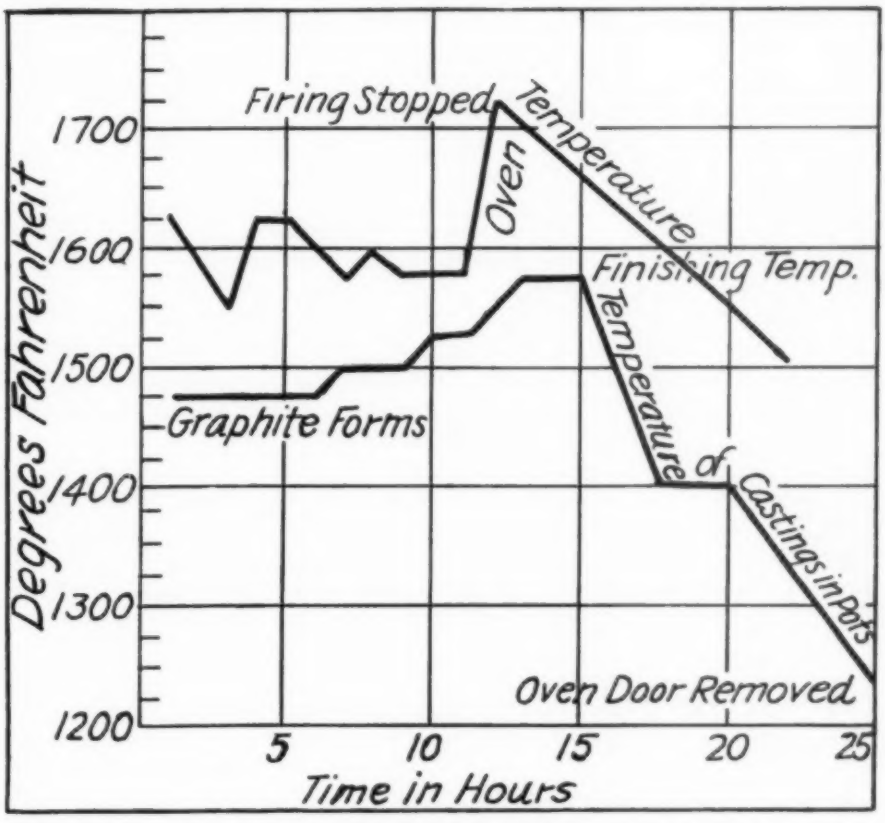


Fig. 3—Curve of a Typical Annealing Cycle with Oven and Castings Temperature. To Heat the Castings to 1475 Degrees Required 38 Hours; To Heat the Oven to 1625 Degrees Required 29 Hours

Chart Finishing Temperature

"These temperatures were diagrammatically shown in the chart, Fig. 2, and are accurate within 10 degrees Fahr. Fig. 3 shows the curve of a typical annealing cycle in an oven containing 14 tons of castings. The carbon in this lot of iron was 2.65 per cent. After the metal reaches the annealing temperature there is no further rise in the temperature of the metal until all the carbon has been changed into the graphitic form. As soon as this change has occurred, the temperature will rise in accordance with the temperature of the oven. It has been found that to heat the castings much above the proper annealing temperature for a long period is not only unnecessary, but a waste of fuel and produces poor castings. After the carbon all has been changed the oven need not be fired for more than 6 hours. When the metal has cooled gradually to 1200 degrees Fahr. the cooling can be hastened as rapidly as desired without injuring the quality of the castings."

The data in Table I shows bar No. 6 was annealed in a 3-day cycle with-

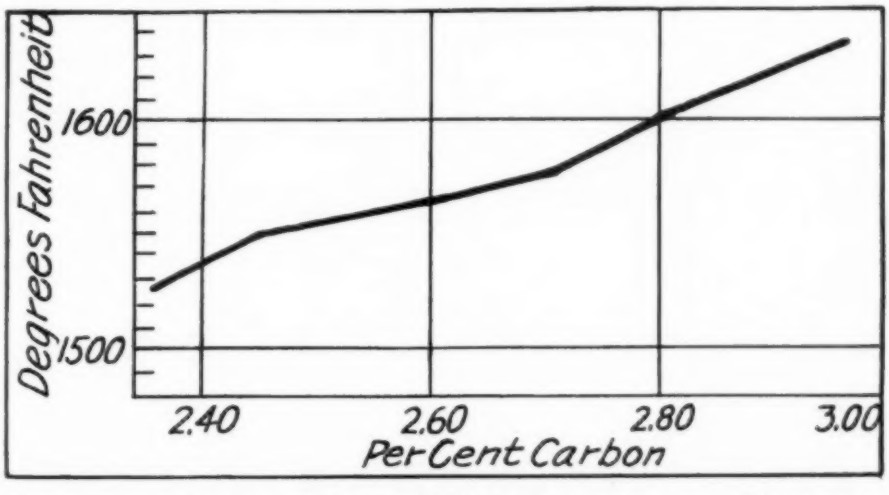


Fig. 2—Curve Showing the Proper Finishing Temperature for White Iron in Relation to the Carbon Content

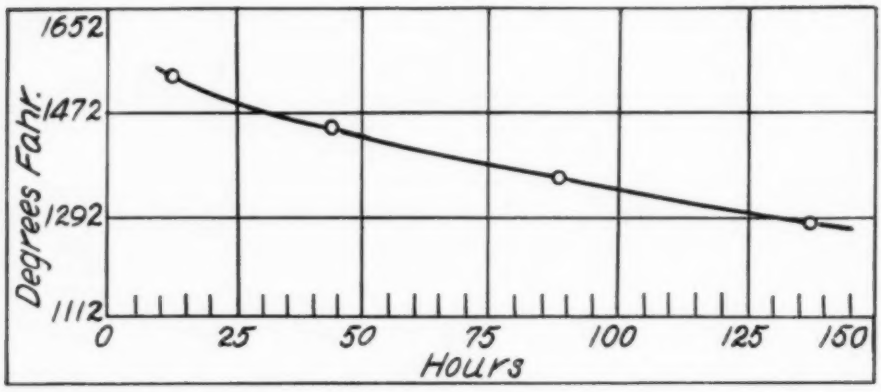


Fig. 4—Time Required To Complete 90 Per Cent of the Carbide Decomposition between 1112 and 1652 Degrees Fahr.

out any packing at 1650 degrees Fahr. The carbon was reduced from 2.70 per cent to 1.71 per cent, and the tensile strength was 40,408 pounds per square inch with an elongation of 8.59 per cent in 2 inches. Bar No. 10 was annealed in a 4-day cycle with mill scale packing at 2200 degrees Fahr. which is extremely high. The high temperature and the type of packing effects are exemplified in the reduction of carbon from 2.70 per cent in the hard iron bar to 0.40 per cent in the annealed bar.

Investigates Several Phases

In 1913 E. L. Leasman carried out a series of experiments on packing materials, temperature of annealing, time of annealing, and rate of cooling, and the data he obtained was presented as a paper at the annual meeting of the American Foundrymen's association held that year. Results obtained by Leasman were ably summarized by O. W. Storey who carried the investigation still further a year later. The summary as given by Storey follows: "1—Packing materials. (a) The packing material does not influence the interior of black heart malleable cast iron. (b) The ordinary packing materials do not directly affect the skin structure by chemical action. (c) A loose packing material, allowing a free circulation of oxidizing gases, will result in a carbonless rim. (d) A slightly oxidizing atmosphere will result in a steely rim. (e) A neutral atmosphere will result in a rim having the same structure as the interior. (f) A slow rate of cooling will tend to result in a rim having the same structure as the interior.

"2—Temperature of annealing. (a) No annealing could be observed below 670 degrees Cent. (1238 degrees Fahr.) (b) The higher the temperature of the anneal (above 670 degrees Cent.) the shorter time necessary to secure a complete breakdown of the white iron. 3—Time of annealing. (a) This factor is dependent upon the temperature of annealing. 4—Rate of cooling. (a) A fast rate of cooling after annealing results in a steely structure. (b) The critical cooling range is between 700 and 775 degrees Cent. (1292 and 1427 degrees Fahr). (c) If the rate of cooling is sufficiently slow in the critical range all of the carbon will be precipitated. (d) If the carbon is entirely precipitated in the critical range the rate of cooling below 700 degrees Cent. (1292 degrees Fahr.) has little effect upon the iron."

Storey's investigations which to some extent were a continuation of Leasman's work, were described in detail in a paper presented at the 1914 meeting of the A. F. A. and probably is the first effort to ascertain when and how cementite is broken down into iron and carbon. By heating perfectly annealed specimens of malleable iron at various temperatures, he found that if heated for 2 hours at 800 degrees Cent. (1472 degrees Fahr.) about 0.25 per cent carbon went into solution. By heating at 850 degrees Cent. (1562 degrees Fahr.) for 5 minutes the entire specimen consisted of pearlite and temper carbon, and was brittle. Further investigation of that question consisted in heating specimens of malleable iron at 900 degrees Cent. (1652 degrees Fahr.) for 5 minutes to insure solution of a certain proportion of temper carbon. The specimens then were cooled to temperatures varying from 650 to 800 degrees Cent. (1202 to 1472 degrees Fahr.), and kept at those temperatures for varying lengths of time. From the data obtained Storey concluded that the critical rate of cooling was between 700 and 775 degrees Cent. (1292 and 1427 degrees Fahr.), and below 700 degrees Cent. (1292 degrees Fahr.) no decomposition of iron carbide occurred. All malleable iron must be cooled slowly to 700 degrees Cent. (1292 degrees Fahr.) to insure a complete breakdown of the iron carbide, and increasing the percentage of silicon will increase the upper limit while increasing the manganese will decrease it.

Time-Temperature Variable

In 1918 R. S. Archer and A. E. White presented a paper before the American Foundrymen's association on the annealing of malleable castings which includes a graph showing the time required to complete 90 per cent of the carbide decomposition between 1112 and 1652 degrees Fahr. as depicted in Fig. 4. The graph indicates that as the temperature of anneal increases the time necessary decreases, and at about 1550 degrees Fahr. the time required is 10 hours. However, from the point indicated, the curve probably rises much more steeply, as the authors mention that a sample was annealed by holding for 2 hours at 1800 degrees Fahr., cooling through the critical, and holding for 5 hours between 1300 and 1350 degrees Fahr.

This is the first of two articles on the shortening of malleable cast iron annealing cycles. The second will appear in an early issue.

The Editors

Table I

Chemical and Physical Properties of Annealed Bars

Test Bar No.	Total Carbon Per Cent	Graphitic Carbon Per Cent	Combined Carbon Per Cent	Elastic Limit lbs. sq. in.	Tensile Strength lbs. sq. in.	Elongation % in 2 inches	Red. of Area Per Cent	Packing Material	Annealing Time Total Hours	Annealing Temp. degrees Fahr.	Test Bar No.
1	1.49	1.49	Trace	29,823	40,996	8.59	12.13	slag	112	1450	1
2	1.94	1.94	Trace	34,134	44,034	10.15	13.87	mill scale	114	1700	2
3	1.47	1.47	Trace	29,276	39,638	8.59	17.63	mill scale	101	1620	3
4	0.86	0.77	0.09	31,428	48,489	8.59	19.18	not given	.....	.....	4
5	1.74	1.74	Trace	30,960	45,760	8.59	14.88	not given	.....	.....	5
6	1.71	1.71	Trace	28,326	40,408	8.59	15.00	none	72	1650	6
7	1.32	1.18	0.14	32,224	49,107	8.59	13.23	not given	.....	.....	7
8	0.80	0.80	Trace	33,333	47,336	7.60	17.27	slag	208	1629	8
9	1.58	1.58	Trace	30,333	39,862	7.03	10.51	mill scale	163	not given	9
10	0.40	0.40	Trace	41,792	50,849	7.45	20.92	mill scale	96	2200	10
11	1.32	1.32	Trace	35,042	45,213	7.80	12.56	slag	144	1700	11

Prevent Losses With Proper Gates and Risers

By Pat Dwyer

ONE of the features characteristic of roll pouring methods might be adopted with profit on the production of many other castings. The pouring basin, really more of a chute or a rectangular funnel in this instance, is set at a height that will insure its complete evacuation by the time the metal has risen to the top of the mold. Instead of a large body of left over iron involving melting cost and handling, the only scrap iron produced in connection with the casting is the metal remaining in the sprue, gate, and sink head.

Less Iron Required

On many molds the runner basins and pouring cups are made up deliberately with this iron saving idea in view. In others no attention is paid to this feature and as a result the amount of iron required to fill the basin cuts down to a material extent the yield of good castings in proportion to the amount of metal melted. This feature of the gating subject was touched upon in a previous number of this series which appeared in THE FOUNDRY Feb. 1. In this connection the following communication from a foundry foreman is of interest, illustrating as it does an awkward situation that occasionally arises. This communication originally appeared in the April 15, 1927 issue of THE FOUNDRY.

On page 246 in the March 15, 1927 issue of THE FOUNDRY a seeker after information claims that his foundry loss over a period of 10 years has not exceeded 3 per cent. A comprehensive reply follows the question under the heading *Foundry Loss Includes Gates and Scrap*, but I should like to ask him one question and that is: Is he sure he gets the correct figures from the charging floor and the shipping scales? I have been in the foundry for many years as a practical molder and foreman and I never yet have seen any person honestly showing a 3 per cent loss. Foundry loss includes metal lost in melting, metal lost in slag and metal in defective castings. If these three are added and taken away from the amount of iron charged in the cupola the loss will amount to more than 3 per cent. Statements like this, 3 per cent loss in the iron foundry and a production of 75 to 85 per cent in the steel foundry frequently place a foreman in an embarrassing position, if they do not actually injure him. A manager or some person in authority reads them and without an intimate knowledge of all the factors, upbraids his own foreman for not being able to duplicate them. I have worked in foundries as molder, inspector and foreman and I never have seen records of that kind.

An old saying in the foundry is that anything is possible on paper. I believe that the foundryman who made the statement on losses is sincere, but he failed to take all the factors into consideration. He is not alone in this respect. I am writing this in the interest of foundry foremen who know better, but who are restrained through policy from expressing their opinion. Of course all practical foundrymen are familiar with the situation, but unfortunately many who sit in the high places are not practical foundrymen.

The foregoing sums up the situation. Any statement on foundry losses is useless unless every factor is taken into consideration, or unless the report distinctly specifies whether it refers to the total loss, the loss in defective castings, the furnace loss, or the amount represented by the gates sprues, spills and over iron. All the metal represented in the difference in weight between the amount charged in the cupola and the amount shipped as salable castings, is not lost in the sense that it has disappeared. The most of it still is in existence as return or shop scrap and the only loss suffered in connection with it is the cost of melting and handling it twice instead of once.

Fasten Gate Pattern

Relative cost usually is the determining factor in deciding which of several methods is preferable in producing any given lot of castings. The claim is not advanced that a core mold, a mold made up of two or more blocks of dried sand, is the best or most economical under all conditions, but in many instances it can be adopted advantageously. It presents all the merits of a dried mold without the attendant expense of flask equipment. Frequently, as in the instance illustrated in Fig. 77, it is possible to pour the mold on edge or in a vertical position and thus dispense with the use of chaplets.

The style of gate illustrated here is used quite extensively on heavy castings, particularly those of large area where good practice suggests the entry of the first metal at or near the bottom of the mold, with additional branches to supply hot metal at successive stages as the metal rises in the mold. In the instance illustrated the casting is comparatively small, but the principle is the same for small or large castings.

The pattern is split in the usual manner and mounted on a board. Instead of a flask, the pattern is surrounded by a plain rectangular frame that serves as a corebox. A number of cores are made with one half of the pattern in place on the board. Then the second half of the pattern is substituted for the first half and a corresponding number of cores are made. Later the halves of

Bottom Poured

IN CHILLED and sand roll molds the iron enters at the bottom from a long sprue contained in an independent casing and terminating at the top in a large rectangular funnel into which the iron from the ladle is poured with great speed. On account of the height of the funnel, all the iron drains out of it by the time the mold is filled. This idea might be adopted with profit on many molds in which under ordinary conditions a considerable volume of iron remains in the pouring basin, later to be removed, broken and carried up to the charging floor. On many large castings it is customary to introduce the first metal at the bottom of the mold and then pour the remainder down through pop gates on the top.

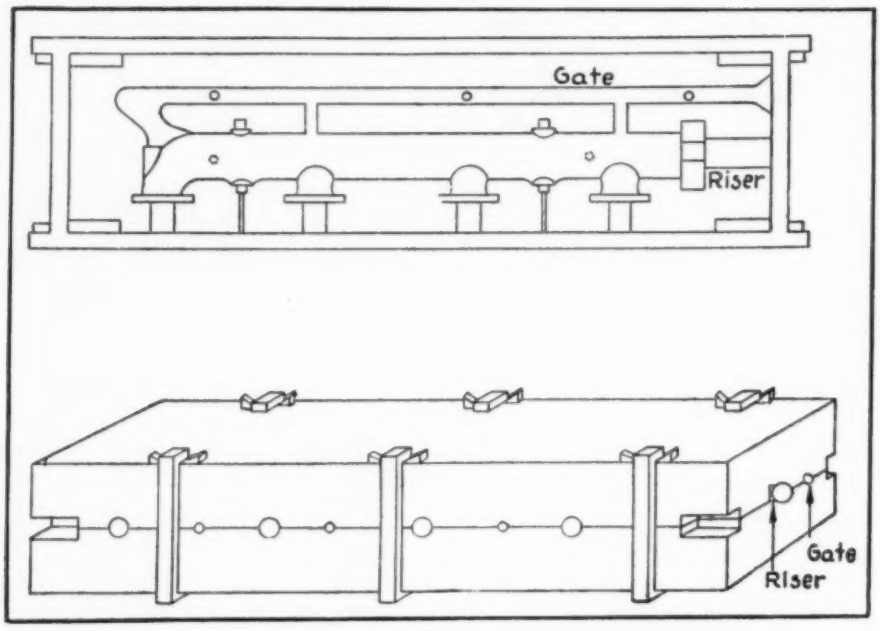


Fig. 77 (Above)—Pattern in Place with the Gate and Riser Attached Inside Core-box. (Below)—Complete Core Mold Closed and Clamped

the core are assembled to form complete molds. In Fig. 77 the first half of the pattern is shown with pattern parts for forming the runner, gate, riser and the vents for the jacket core. The runner and gate are omitted when the second half of the pattern is placed on the board. The dowel pins on the board are arranged in such a manner with relation to a center line that the halves of the mold will coincide perfectly when the joint surfaces are brought together. The assembled mold is placed in the oven for a short time to dry the paste and blacking and then is upended and made ready for the metal. In some instances daubing the joint and clamping the cores is sufficient. In others it may be advisable to surround the cores with a flask and ram sand between the cores and the wall of the flask to secure them.

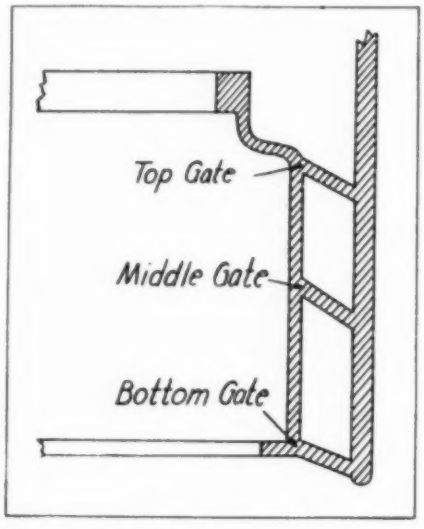


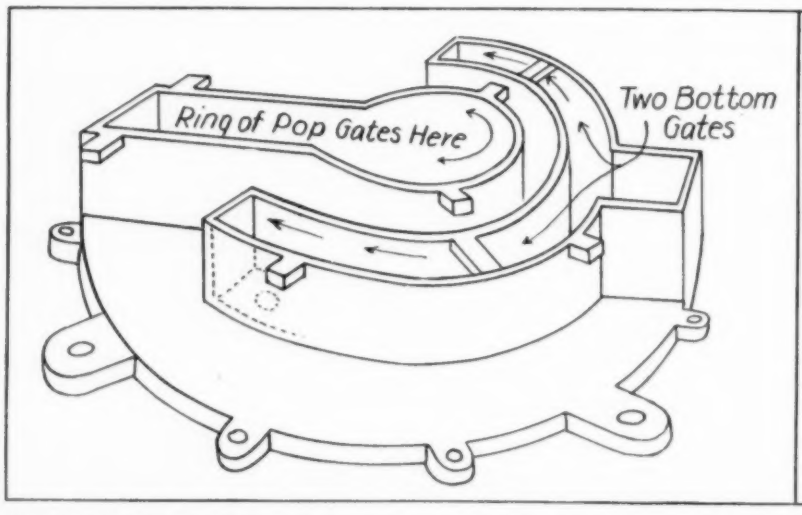
Fig. 78—Casting Gated at Bottom, Middle and Top

Where the foregoing type of gate is employed on large castings the various parts of the passage are made up in tiles, in cores or by suitable pieces of wood which are withdrawn after the mold has been formed. Details of these various types have been presented in preceding numbers of this series. Application of gate and sprue to a large circular casting, flanged top and bottom and with a shoulder near the top, is shown in Fig. 78.

The first metal enters the mold quietly at the bottom flange and rises in the side walls to a point near the center of the vertical height. At this point, with the metal in the mold and the metal in the sprue approximately level, the source of inlet is changed and metal commences to pour in through the middle gate. Later, this process is repeated at the top. The net result is that fresh, hot metal constantly is entering the mold in the areas where it most is needed. The strain incident to introducing all the metal at the bottom under a gradually increasing head, is reduced. The casting commences to cool first at the bottom and the movement progresses gradually upward in accordance with the dictates of desirable practice.

A variation of this method is shown in Fig. 79, the runner basins and cover plate of a loam mold for a 50-ton gas engine cylinder. The basin on the right supplies metal to two upright sprues made of 4-inch tile built into the brickwork diametrically opposite each other and extending to the bottom of the mold. Two flat gates 1½ x 5 inches at the bottom of each sprue conduct the metal into the mold. These gates are arranged tangentially to impart a whirling motion to the metal and thus keep in motion any impurities that might collect.

The runner basin at the left car-



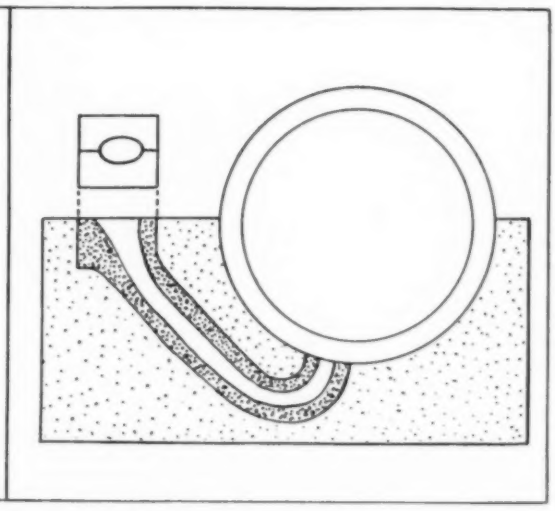


Fig. 79 (Left)—Layout of Runner Boxes for Large Gas Engine Cylinder. Fig. 80 (Right)—Horn Gate Is Formed in Dry Sand Core Placed in the Mold

ries the metal to a ring of 1-inch square pop gates surrounding the center or barrel core. Metal is poured from two ladles simultaneously with the exception that a cushion of metal from the bottom gates is allowed to accumulate before the metal commences to stream in through the ring of pop gates on the top.

Although many gas engine cylinders, small and medium size, are molded horizontally from split patterns, the almost universal custom is to cast them while in a vertical position. The principal reason for this is the difficulty experienced in holding the jacket core in place in a horizontal mold. Occasionally conditions dictate the necessity of using the horizontal method. In instances of that kind and also for other castings besides gas engine cylinders, the horn gate shown in Fig. 80 is particularly applicable. It is made in halves in a simple core-box and afterward the dried halves are pasted. The gate core is placed in position, one end on the rollover board and one end on the pattern, just as if it was a solid pattern for a horn gate. It is rammed up as part of the drag and the upper end is stuffed with waste or covered with a thin plate until after the cope has been lifted off. Blacked and dried, this form of gate insures a clean passage for the metal.

Gears Present Difficulties

Theoretically, if one casting made by a molder is good, then all the castings made by that molder on the same day and under like conditions also should be good. How happy the foundrymen of the world would be if this theory only worked out in practice. Under exceptionally favorable circumstances the percentage of lost castings may be kept to an exceedingly low figure, but there never was and quite probably never will be a foundry in which all the castings made will grade 100 per cent perfect.

The foregoing observation applies in a particular manner to gears and gear blanks. Owing to the character of the casting it is apparent that the greatest care is required in making the mold and in pouring the iron. The casting must be perfectly clean on the outside and perfectly clean and solid on the inside. From this it is apparent that the runner, gate and mold must be perfectly clean. Also that the iron must lie perfectly quiet in the mold. After a foundryman has taken proper precaution to insure the foregoing condition he can do no more.

However, it may not be out of place to suggest a checkup on present practice. See that the sand is open and worked a little on the dry side. A drag may be too shallow or the bottom board or plate may be fitting too tightly for the steam to escape. For small gears or gear blanks a ring of pencil gates in a strainer core over the hub will insure clean iron and even distribution.

A shrink hole opposite the arm in the rim of a gear blank is a form of defect that does not come to light until after the casting is partly machined. In fact, due to the perversity of inanimate objects, the defect in some instances does not show up until the machine is cutting the last tooth on the rim.

This form of defect may be traced to one or more of many causes and may be prevented by anticipating

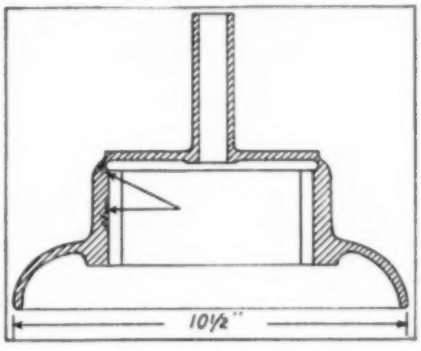


Fig. 81—Dirt in Varying Quantities Is Arrested by Contact with the Vertical Walls of the Mold

certain effects due to certain causes. This has reference to a shrink hole pure and simple and not a cavity caused by gas, steam, slag or sand. Holes due to these various causes present a characteristic appearance and may appear any place in the casting. The fact that the holes appear only at points opposite the arms may be regarded as fairly conclusive evidence that they are shrink holes in the casting.

Primarily these holes are due to the fact that the thickness or bulk of the rim on a blank gear is out of all proportion to the thickness of the arms and hub. The rim is the last part of the casting to become solid and consequently it serves to feed the other parts. When its own time comes, no more liquid metal is available and the feed pockets that were drained by the arms remain unfilled.

The ideal method of curing the trouble would be to redesign the pattern so that the rim would be the lightest and therefore the first part of the casting to become solid. However, that method is out of the question, because a hub and arms out of apparent proportion to the rim in the rough would be too heavy altogether for the rim after the teeth were cut. The foundryman must accept conditions and patterns as they are and then take certain measures to circumvent the laws which nature has evolved.

The most efficacious method to adopt will depend on local conditions, the size and shape of the casting, the analysis of the iron, whether the casting is made in a green or a dry sand mold and maybe one or two others. In some instances the trouble may be cured by sticking one or more large head nails into the mold at the junction of each arm with the rim. The nails are allowed to project into the mold cavity so that the heads occupy approximately the position in which the shrink holes have appeared or are expected to appear. These nails will act as internal chillers and prevent the metal from drawing away at that point. Naturally care must be observed to see that the nails are perfectly clean and dry. A dirty, damp or rusty nail will create more cavities than shrinkage, in the rim of the wheel.

Other Methods Practiced

In some instances an extra high pouring head and a number of feeders on the rim will insure solid rims on blank gear wheel castings. In others the outside of the rim is formed in an iron chill, either in one part or in several segments. These chillers do not chill the face of the casting in the ordinarily accepted foundry sense where it means that the carbon is thrown into or rather held in the combined form and the iron in contact with the chiller becomes white. In the particular instance under discussion that analysis of the iron is regulated so that the rim of the casting will be densened but not chilled. The iron will be close grained but it will be machinable.

Occasionally shrink holes in castings are caused by the style of the gate, while in others where the gate may be perfect in design and construction, the shrinkage is caused by the speed at which the metal is driven into the mold. A low pouring head or low riser is a prolific cause of shrinkage in castings that require a little manipulation in the mold. Many castings may be poured successfully in open sand molds or in molds under exceedingly shallow copes. These castings are uniform in cross section or otherwise designed to shink normally and uniformly. Gear blanks, and other castings of peculiar shape must be treated with care and certain precautions must be observed to secure solid castings.

In another type of defect shown in Fig. 81 the porous or dirty areas are due to a combination of dirt and shrinkage. This casting is poured through a gate at the bottom and gear teeth afterward are cut on the interior of the ring. The defective areas do not appear until after the casting has been partly machined. Under ordinary conditions and with the iron usually poured into castings

(*Concluded on Page* 41)

Thomas Smedley

Herbert Larson

B. J. Kafczynski

William Norton

Louis Chick

Victor Sanders

Rollo Van Camp

Ralph Adams

Edward G. Janda

CONTEST DEVELOPS Initiative and Ability

A REMARKABLY fine showing was made by the boys who submitted specimens of their skill in the apprentice patternmaking sponsored by the American Foundrymen's association at the recent convention of the association in the Stevens hotel, Chicago. Had the contest been based merely on workmanship, finish and general appearance, the three judges probably never would have arrived at a unanimous decision regarding which pattern was entitled to first, which to second and which to third place. Fortunately the terms of the contest set up a number of restrictions. Failure to comply with one or more of these restrictions eliminated several patterns from the contest.

Several highly finished and excellent examples of pattern construction were rejected on account of the time element involved. Instruction on the blueprint indicated that the pattern was to serve on an order for 10 castings. The time consumed in the construction of the rejected patterns ruled them out of the commercial class.

Patterns which conformed to all the specifications were judged on a point system under four headings: Accuracy to blueprint, moldability, workmanship and time.

Under the first heading all the patterns received a practically perfect score. Even those showing minor imperfections were within commercial limits. One otherwise perfect pattern was rejected under this heading through a simple oversight on the part of the maker. In measuring the cavity in the round corebox, apparently he had forgotten to allow for the thickness of metal at the inner end. This is a common error and would have evoked little comment in everyday practice, outside a request from the checker to shorten the corebox. However, in this particular instance where the pattern was supposed to be ready to go into the production, the judges had no choice

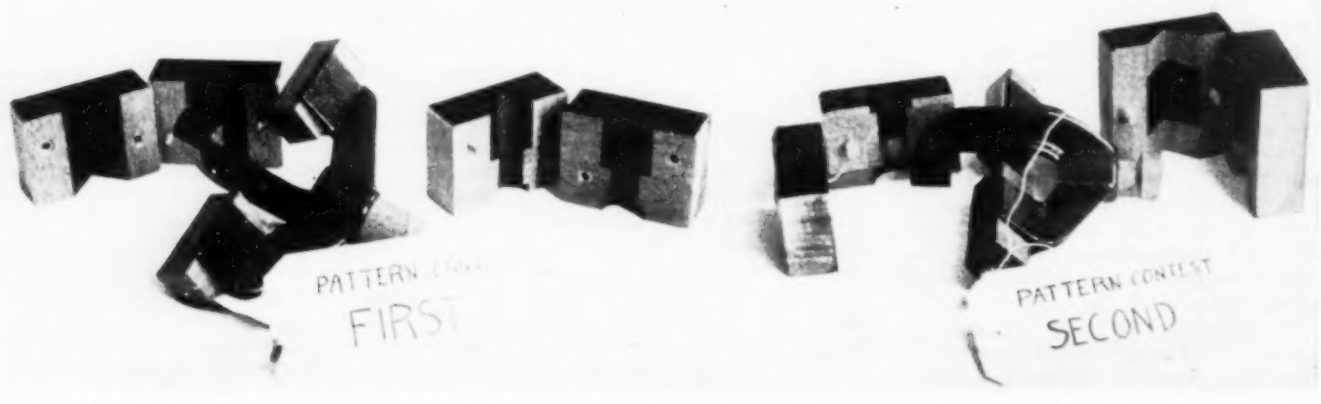


Fig. 1 (Left)—This Pattern Was Awarded First Place. Fig. 2 (Right)—This Pattern, Differing Only Slightly From the First, Was Given Second Place

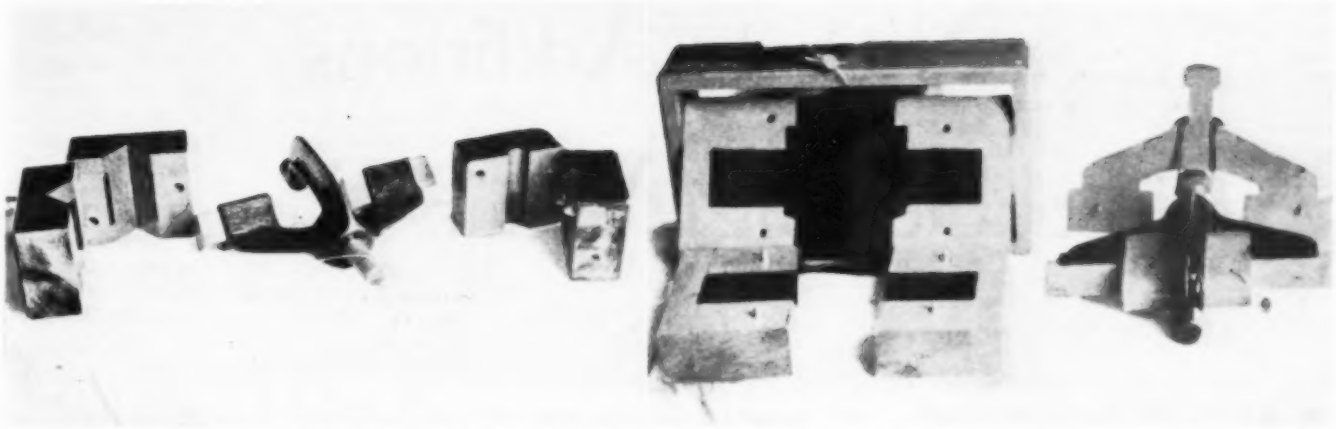


Fig. 3 (Left)—This Type of Round Core Print Was Not Considered As Good As That Shown in Figs. 1 and 2. The Pattern Was Given Third Place. Fig. 4 (Right)—The Dry Sand Core for This Split Pattern Required a Sand Frame or Drier

but to ignore it in their decision.

The item known for want of a better term as *moldability* was the rock on which most of the entries came to grief. This emphasizes the claim advanced by practically all foundrymen that a patternmaker should have a period of actual foundry experience. A comparatively short period in the foundry will teach him more of what actually is needed in a pattern, than years at the pattern bench where knowledge is absorbed through hearsay and remote contact.

In this instance a solid one piece pattern with one cylindrical and two rectangular core prints is the most suitable. For molding this pattern it is assumed that the molder would prepare a sand match. This type of pattern, with minor variations, is shown in Figs. 1, 2 and 3. The slight difference in the style of cores and core prints was practically all that influenced the judges in their classification of first, second and third.

Some of the patterns were split and a large core print placed in the center to provide a flat parting line. This pattern required a greater dry sand core than the others. Also a drier or sand frame was required to hold the core in position while drying. This type of pattern is shown in Fig. 4 with the corebox and sand frame to the left and the two parts of the split pattern to the right.

One pattern was peculiar in that it was parted directly opposite to all the others in that manner constituting an example opposed to regular practice. It was well made and accurate and showed a certain amount of ingenuity that doubtless will stand the boy in good stead later.

The time element, varying as it did from 10 to 30 hours, really was the deciding factor in the classification. Under this heading the high score was 20 points out of a total

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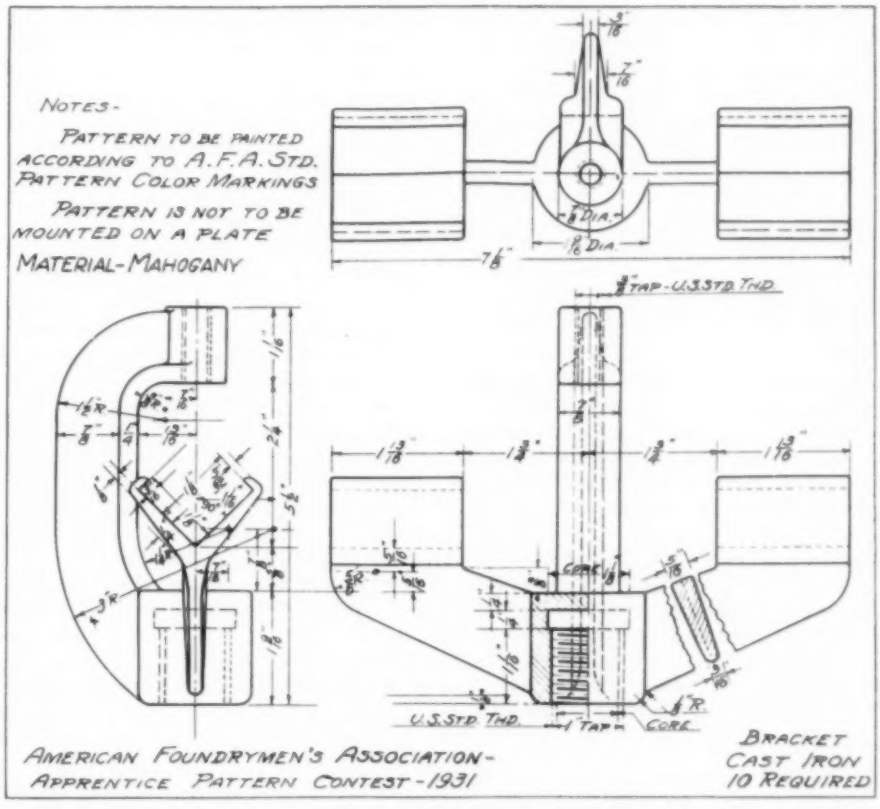


Fig. 8—Reproduction of the Blue Print From Which the Patterns Were Made

Fig. 5 (Left)—The Coreboxes Are Ingenious but Unnecessarily Intricate. Fig. 6 (Center)—Another Type of Split Pattern. Fig. 7 (Right)—A Third Type of Split Pattern Made Up To a Considerable Extent of Dry Sand Core Prints

Nickel Additions Affect Bearing Wear Resistance

By James Brinn

METAL cost is of considerable economic importance in the production of bearing bronzes as well as in other metals. In 1926 when the price of tin rose to 75 cents a pound and there was much talk about a tin famine the suggestion was made to substitute part of the tin with nickel in the 80 per cent copper, 10 per cent tin and 10 per cent lead bearing alloy. It was known that addition of nickel improves the grain structure of bronzes and makes denser castings. Therefore, a small percentage of nickel often is added to pressure castings, and it was thought that by replacing tin with nickel, not only a cheaper but also a better bearing would result.

Add Varying Nickel Percentages

For preliminary tests five alloys were made up in coke-fired crucibles and poured into test bars 1-inch in diameter in sand molds. The alloys were the regular 80 per cent copper, 10 per cent tin and 10 per cent lead alloy, and alloys which had been derived from this alloy by replacing 0.5, 1, 2 and 3 per cent tin with the same percentages of nickel. Tensile and brinell hardness tests were conducted and photomicrographs taken. It was found that the alloys containing 0.5 and 1 per cent nickel did not vary to any noticeable extent from the regular alloy, but the alloys containing 2 and 3 per cent nickel possessed a higher elastic limit and a lower elongation and reduction in area than the others.

Brinell hardness was increased considerably. At a distance of 1/16-inch from the surface, the brinell hardness of the regular alloy varied from 60 to 70, while for the 3 per cent nickel-containing alloy, it varied from 85 to 100. The microscopical investigation showed that the structures of the 0.5 and 1 per cent nickel containing alloys did not differ to any marked extent from the regular alloy, while the 2 and 3 per cent nickel containing alloys exhibited a finer and more uniform lead distribution as shown in Fig. 2.

As a result of the tests decision was made to try out a nickel-containing bronze in street car bearing service, and an alloy containing 81 per cent copper, 7 per cent tin, 2 per cent nickel and 10 per cent lead was chosen. A number of bearings were made of this alloy and placed in service together with bearings made of the regular 80 per cent copper 10 per cent tin and 10 per cent lead alloy, to obtain strictly comparative results. All bearings were poured into sand molds.

After about a year and a half the cars were taken in for overhauling, the bearings dismantled and the wear of bearings and axles measured. It was found that the nickel-containing bearings had worn considerably more than the regular, but the wear of the axles was approximately the same for both alloys.

It may appear strange that the nickel containing bearings, despite their greater hardness and more uniform grain structure, should be inferior to the regular alloy bearings. However, this has been found in another investigation published in the bureau of standards, *Journal of Research*, August, 1930. Addition of 2 per cent nickel to an 80 per cent copper, 10 per cent tin and 10 per cent lead alloy prevents segregation of lead, but decreases the resistance to wear according to that research. It also is stated that the nickel addition resulted in the metal having a tendency to oxidize both in the crucible and the mold.

Structure Is Finer

A fine-grained structure and greater hardness can be brought about—without changing the chemical composition—by pouring the metal into chill molds instead of sand molds. It is of interest to note that in an investigation on wear and mechanical properties of bearing bronzes, conducted by H. J. French and coworkers and reported in *Research Paper* No. 13 issued by the bureau of standards in 1928, it was found that chill-cast

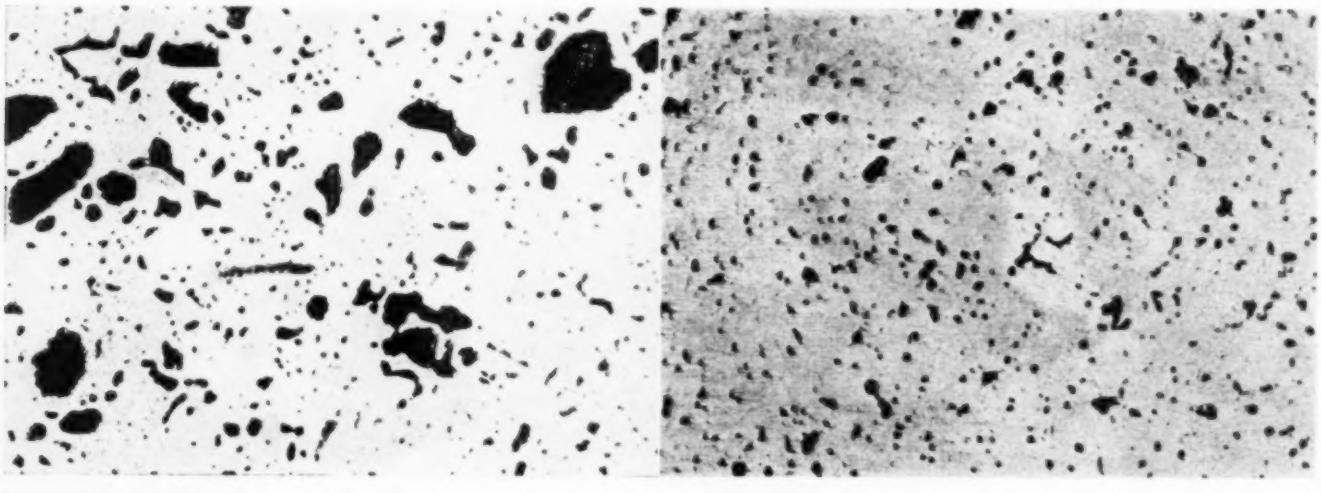


Fig. 1—Micrograph Showing the Lead Dispersion in the Regular 80-10-10 Alloy. Fig. 2—Nickel-Containing Bearing Alloy Shows a More Uniform and Finer Lead Dispersion

bronzes as a rule wore faster than sand cast.

The question now arises why should a hard and dense bearing structure be inferior to a less hard, open-grained structure from the viewpoint of wear resistance. A brief discussion of the essential properties of a bearing metal will give the answer. To begin with, it must be stated that in a theoretically perfect bearing, the load should be carried on a film of oil between the shaft and the bearing, and the nature of the bearing alloy should therefore be immaterial.

However, such perfection is not realized in actual practice and the nature and properties of the bearing metal consequently must be such as to minimize as far as possible the inevitable errors of adjustment and alignment. Therefore, a bearing alloy is made up of two phases, that is, it consists of hard and soft crystals, intimately mixed. The function of the hard crystals is to support the load and resist the wear and the function of the soft crystals is to allow the hard crystals to adjust themselves to the shaft and to wear down slightly below the surface of the hard crystals, forming slight depressions on the apparent smooth wearing surface of the bearing in which some of the oil is held.

Bearing Is Plastic

It is that property of allowing slight depressions to form and thus provide the means for retaining oil that is characteristic for a bearing metal. In fact, a bearing metal has been defined as, "--an alloy that is capable of retaining a lubricant upon a bearing surface," according to a report of the subcommittee on bearing metals, American Society of Mechanical Engineers, 1919. The extent to which the lubricant can be held so determines the most valuable characteristic of an alloy as a bearing metal.

Since it is softer, a sand-cast bearing of the regular 80-10-10 alloy will have a greater ability of conforming to a steel shaft than a chill-cast bearing of the same composition or a sand-cast, nickel-containing alloy. Since it has a coarser grain structure or what the foundryman terms an *open grain*, the former bearing in all likelihood has a greater capability of retaining a lubricant upon its bearing surface. This in conjunction with the fact just stated indicates that the sand-cast 80-10-10 alloy is the superior bearing.

It should not be concluded from the foregoing that sand cast bearings with pinholes, sponginess, porosity or excessive large grains will make superior bearings. All that the author has desired to call attention to is, that practical service tests and research investigations indicate that improvement in grain structure and brinell hardness of bearing bronzes lessens the wear resistance. Addition of 2 per cent nickel to the 80 per cent copper, 10 per cent tin and 10 per cent lead bearing bronze or pouring bearings of this alloy into chill molds results in shorter life of the bearings. Sand cast bearings of the regular 80-10-10 alloy made under proper foundry conditions are the most desirable from the service point of view.

Prevents Losses

(*Concluded from Page* 37)

of this kind, this casting should shrink normally and show no segregation in the comparatively heavy band in which the teeth are to be cut. There a small quantity of dirt lodges at the points indicated by the arrow, the dirt forms a cavity and in addition prevents the iron in the vicinity from shrinking normally. As a result, the cavity is accentuated and usually is diagnosed merely as a shrinkage cavity, when in reality the shrinkage is only incidental and a follower of the real cause, dirt either washed in from a carelessly constructed gate or sand washed from the face of the mold.

Obviously the remedy for this condition is to provide a perfectly clean mold in which the sand is tempered, rammed and vented properly to prevent the slightest commotion while the iron is filling the mold. Particular attention should be paid to the passage through which the iron passes from the top of the cope to where it enters the mold at the bottom. The gate *may* be responsible, but in the majority of instances of this kind the condition of the sand in the mold is to blame for the defects in the casting.

This is the fifteenth of a series of articles dealing with the various types of gates and risers used in the foundry industry. The sixteenth installment will appear in an early issue.—THE EDITORS.

Committee Is Approved

Personnel of the committee preparing revision of the safety code for the protection of industrial workers in foundries has been approved by the American Standards association standards council. This code is being prepared under the sponsorship of the American Foundrymen's association and the National Founders association. Co-operating bodies, in addition to the sponsors, which have appointed representatives on the committee, are: American Society of Mechanical Engineers; American Society of Safety Engineers; engineering section, National Safety Council; Association of Governmental Officials in Industry; Cast Iron Pipe Research association; National Association of Manufacturers; National Association of Mutual Casualty Companies; National Bureau of Casualty & Surety Underwriters; National Founders association; National Safety council; National Safety Council, equipment manufacturers section; Pennsylvania department of labor and industry; Steel Founders Society of America; U. S. bureau of standards; U. S. department of labor; U. S. bureau of public health service. W. C. Wright, foundry consultant, is serving as a member-at-large.

The original code for this project was approved in 1922 as American tentative standard. The present revision is intended to bring the code up to date and advance it to a standard. The temporary committee, while waiting approval, has been at work on the revision and final draft will be completed within the next 2 months.

Develops Initiative

(*Concluded from Page* 39)

100 points under all headings. Thus with the shortest time 10 hours and entitled to a score of 20 points, the contestants who had spent 30 hours on the job could receive only 6.66 points. In some instances this reduced the total score materially, although relatively high scores may have been made under other headings.

First place was given the pattern shown in Fig. 1 made by Herbert Larson, John Deere Harvester Works, East Moline, Ill.; second place went to B. J. Kafczynski, Geo. H. Smith Steel Casting Co., Milwaukee. His pattern is shown in Fig. 2. The pattern awarded third place and shown in Fig. 3 was made by Edward G. Janda, Milwaukee Pattern & Mfg. Co., Milwaukee.

The patterns were examined and awards made by a committee of three: A. Beck, Western Foundry Co., G. T. Johnson, Western Electric Co., and Fred Erickson, Arrow Pattern & Foundry Co., all of Chicago.

Gray iron molding and steel molding contests also were judged during the convention. Winners in these contests, as announced in the May 15 issue of THE FOUNDRY, were as follows: Steel Molding-1. William Norton, Hubbard Steel Foundry, division of Continental Roll & Steel Foundry Co., East Chicago, Ind., 2. Ralph Adams, Birdsboro Steel Foundry, Birdsboro, Pa., 3. Louis Chick, Hubbard Steel Foundry division of Continental Roll & Steel Foundry, East Chicago, Ind.; Gray Iron Molding—1. Thomas Smedley, Red Jacket Mfg. Co., Davenport, Iowa, 2. Victor Sanders, John Deere Harvester Works, East Moline, Ill., 3. Rollo Van Camp, French & Hecht, Inc., Davenport, Iowa.

Questions & Answers on FOUNDRY PRACTICE

GENERAL

Sand Sticks to Driers

Our radiator core driers are caked badly with carbon from the oil which not only makes a rough core, but increases the weight of the castings due to the smaller core. We have tried soaking the driers in sulphuric acid, but it only appears to attack the drier. Gasoline was better, but not satisfactory.

A variety of methods are used to clean core-drying shells. They may be cleaned by sandblasting, pickling and tumbling with other castings. Pickles used include a solution of 10 parts of water to 1 part of 30 per cent hydrofluoric acid. Ten per cent muriatic (hydrochloric) acid sometimes is added to give more rapid action. The driers are left in the solution for several hours. Use the solution warm, but not hot. Hydrofluoric acid solutions are quite corrosive, and the operator must be supplied with rubber gloves, apron, goggles, etc. to protect him. After the burned sand is removed, the driers are washed in clean, warm water; dried and rubbed with kerosene.

Several proprietary cleaning compounds for removing sand from castings are on the market which probably will be suitable for cleaning the driers. Undoubtedly, your foundry supply house handles one of them, and will be glad to give you information. Cleaning the driers at definite intervals not too far apart may be easier.

Q & A

Describes Loss Sheet

Do you know whether a standard inspection report of scrapped castings is in existence, and if it is used by foundries?

As far as we are aware, there is no standard report form of the type you mention. However, a great many foundries employ loss sheets of some kind or other to keep track of the causes of losses. These vary from those including only a few general divisions to others quite elaborate and giving every possible minor and major cause. Usually, the forms are made up by the individual foundries to give the information that they desire.

For example, in the Sept. 15, 1927 issue of THE FOUNDRY, J. M. Haley gives a table of loss allocations which may give some idea of the causes of casting defects. He divides the loss into two major divisions, the foundry and the machine shop. Under the foundry losses he includes the following: 1—Molders' Defects—(a) cuts, (b) drops, (c) blows, (d) not run, (e) cold shut, (f) miscellaneous which includes cores off center, core crushed, core tipped, flask shifted, strain, bad patching, runout, core left out, scabs, and hard ramming. 2.—Shrinkage—(a) shrink cavities, (b) shrink cracks. 3—Dirty Castings—(a) sand inclusions, (b) slag inclusions. 4.—Foundry Breakage. Under Machine Shop losses he includes: 1—Porosity, 2—Dirt Inclusions, 3—Blow Holes, and 4—Hard Iron.

With such data you can make out a loss report form to fit your case. We suggest a wide column at the left for the molders' names and numbers. To the right of that column, the various loss causes as enumerated previously can be placed in narrower columns. Also, you may wish to include other losses not mentioned so it is an easy matter to extend the vertical columns to cover those.

THIS department covers all problems relating to metallurgical, melting and molding practice encountered in making steel, malleable-iron and gray-iron castings. Questions submitted by bonafide subscribers to this department will be answered by members of the editorial staff of The Foundry, supplemented where occasion requires by the advisory staff whose personnel is as follows:

John H. Hall
Cast Steel

H. A. Schwartz
Malleable Cast Iron

J. W. Bolton
Gray Cast Iron

All questions must be addressed to the Editor, The Foundry, Penton Building, Cleveland.

Q & A

Add Water to Core Sand

In a recent issue of THE FOUNDRY *I read an article dealing with the production of cores in large quantities in an automobile foundry and I wondered how the moisture difficulty is solved. Presumably the cores are made from sharp sand. I use a proprietary oil binder, but I have to dry all the sand and then cool it before adding the binder. I do not use any water. I also find that many large foundries in this country that make up their own bonding mixture, insist on drying the sand first, although afterward they may add water to the mixture. Is sand drying a general practice in the large American motor shops? Is it common practice to add molding sand to a core sand mixture? Does the molding sand increase the green bond strength of the cores?*

Sand drying is not practiced to any great extent for the simple reason that in most cases it is not necessary. The core sand is stored under cover in large quantities where any water readily evaporates from the top layers. All the sand entering the mixers is due to receive a certain amount of water as well as oil or other bonding material. The automatic mixers are provided with water sprinklers for this purpose. Where the sand is damp enough, no further water is added, but generally speaking a certain amount of water must be added to every batch. The amount of oil, one part to 50 or more sand, would

not convert dry sand into a workable condition. However, in some instances, for example in making water jacket cores for automobile cylinders, better results have been obtained by first drying the sand, adding the oil and mixing and then adding a definite amount of water.

It is common practice to add a definite amount of new molding sand to core sand mixtures, providing the addition of this material does not interfere with the required permeability of any given core. For example no molding sand is added to the sharp sand used in making automobile water jacket cores, or other cores of a related character where the escape of the vent rapidly and easily is a factor of paramount importance. Increase in the green sand bond strength practically is the only reason for adding molding sand to a core sand mixture.

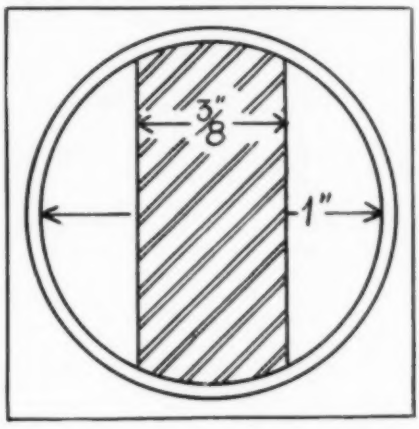
GRAY IRON

Core Arbor Expands

Up to the present we have been unable to develop a satisfactory method for producing 2-inch soil pipe. We have tried standard 1¼-inch steel pipe, 1⅝-inch on the outside, reinforced with 1-inch pipe on the inside, for arbors. The two pipes were welded electrically, but they bent in service. Invariably the cores sagged downward in the center, instead of bending upward as one might expect. The broken castings showed an excessive thickness on the top. Do you think a 1-inch steel pipe with a flat steel strip in the center as shown in the accompanying sketch, would serve as an arbor. Several years ago we read an article in THE FOUNDRY *describing the manufacture of small pipes at the Bingham & Taylor foundry in Buffalo. Unfortunately we have no back number to which we might refer for particulars.*

The article to which you refer appeared in the Aug. 1, 1919 issue of THE FOUNDRY and referred to castings 2½ or 3 inches diameter, known as water shutoff boxes. They are the castings placed vertically near the curb line in a street and afford access to the rod by which the valve opening or closing the water line to the house, is controlled. The following excerpt from the article covers the core arbor construction:

The arbors are cast iron and are carefully machined at each end. The short ones are plain on the inside but the long arbors are reinforced with four internal ribs extending longitudinally. This style of arbor is perfectly rigid and by its use, chaplets are dispensed with in pipes up to 6 feet in length. An interesting feature in connection with these core arbors is the method adopted for putting the vent holes in them. This is accomplished by sticking four rows of well tapered little chills at intervals of 1½ inches in the drag side of the mold. The core holds them in place and after the castings are poured, these chills are knocked out and removed to be used again. No vent holes are provided in the top side of the arbor. When the arbor is in use of course the position is reversed. That is the vented side always is kept up. The arbors are claywashed before they are used and for this reason the sand for the cores is mixed considerably drier than would be the case under ordinary conditions. The sand thickness on the core is approximately ⅜-inch and of course the sand absorbs nearly all the moisture from the arbor. This is one of the most ticklish features in connection with making these cores in green sand. The problem is to have



Is Reinforced with Steel Strip

the sand damp enough to hang to the arbor and still allow for further absorption of moisture without producing a core too wet to pour iron against.

Although we never have seen a small pipe arbor reinforced with a steel strip as shown in your sketch, the idea seems perfectly feasible.

The statement that your cores bent downward in the center seems to indicate either slow pouring or an improper position of the gates. The exceedingly thin coating of sand also has been a contributory factor. The lower side of the arbor became highly heated in advance of the remainder, and expanded. The mold should be filled as rapidly as possible to equalize the heating effect all around the arbor. To this end the usual custom is to pour these castings from a multi-lip ladle that fills four sprues simultaneously. Each of these sprues delivers metal to a long continuous runner at the joint which in turn discharges the iron into the mold through a number of branch gates. In effect the iron enters the mold through a multiplicity of gates extending throughout the entire length and in this manner fills the mold almost instantly. Thus when the arbor starts to expand, it expands uniformly and in a straight line from end to end.

Q & A

Obtains Good Results

We operate a cupola lined down to 41 inches, which has 6 tuyeres 5 x 8 inches at the small end. The tuyeres are 17 inches above the bottom plate. We use by-product coke containing about 88 per cent carbon, but do not seem to be able to get iron hot enough at the start unless we have the bed 36 inches above the tuyeres. However, with 125 pound coke splits the succeeding charges are too hot unless we reduce the coke. Our iron charges weigh 1600 pounds with 5 per cent steel scrap. The bed weighs 1010 pounds. Iron shows at the taphole in 3 or 4 minutes after the blast is on. We light up at 1 p.m. and put the blast on at 3:30 p.m. We melt four charges and from time of blast to drop of bottom is 37 minutes.

If you can obtain hot iron with a 36-inch bed, you should not complain. Many foundries have to use coke beds up to 42 inches so that hot iron may be obtained. As a matter of fact, if you put in a 36-inch coke bed and let it soak for 2½ hours as stated, and if there is any draft at all, your bed height probably is in the vicinity of 24 inches when the wind is turned on. Furthermore if you melt a 1600-pound charge with 125 pounds of coke, your melting ratio is nearly 13 to 1 which is excellent.

The first iron melted usually is a little duller than the succeeding iron. It usually takes from 15 to 25 minutes to obtain the maximum melting temperature. The first iron loses heat because it must supply heat to the cold sand bottom, and the cold spout. When those become hot, the iron becomes hotter as less heat is given up to the parts mentioned and the lining of the cupola.

MALLEABLE

Different Methods Used

In recent years certain manufacturers of malleable castings have developed a process for producing a superior grade of castings, so far as greater tensile strength, yield point, and wearing qualities are concerned. If possible please give me information on how these castings are produced with analysis of the iron, whether a special heat treatment is used, etc.

The material referred to represents malleable in which the matrix instead of being pure ferrite, contains combined carbon as pearlite or sorbite. It is made in some instances by interrupting the anneal before completion; in others by recombination of some of the carbon by reheating. The processes involved in many cases are patented.

Often the metal is of the usual ultimate composition, occasionally higher manganese is used. When not covered by patents the processes usually are considered as trade secrets. Iron of unusual strength and ductility also has been produced by the orthodox methods by reducing the total carbon in the melt to about 2 to 2.20 per cent with a silicon around 1 per cent. Such material is entirely normal malleable cast iron in structure.

Problems in Nonferrous Founding

By Charles Vickers

Sand Is Too Tight

We are sending you a sample of bronze cut from a defective tablet casting. You will note that the metal has separated through the center and this has occurred throughout the entire casting which is 12 by 24 inches. The castings would have split into two pieces had it not been held together by a sound thickness of metal at the extreme outside edges. The casting was poured from standard metal of composition 85 copper; 5 tin; 5 zinc and 5 lead, and was poured at a medium temperature. We have discussed this phenomena with several local bronze foundrymen and none knew exactly what caused the separation.

This sort of thing always proves a puzzle and many and varied have been the reasons given in explanation thereof. Have you examined the broken sample of brass under a magnifying glass? If not, do so, it will be noted that one layer has a different fracture to the other layer. Which was made in the cope, we are unable to determine, of course as there is nothing to indicate it, but we would imagine that the smoothest side, the one carrying a rib was in the cope.

Still using the magnifying glass it will be noted that this layer which we imagine was laying on the drag side is filled full of little holes which are tiny. The other layer carries some also, but nothing in proportion. The cause of the splitting as we see it is nothing but gas simply steam from the mold. It was generated at the point of contact of the metal and the flat mold. It could not pass into the latter, due to its impermeability, so it was compelled to pass into the metal, the gas could not pass through the entire thickness of the metal. Some did, but only a small portion. Consequently, it spread in a thin lateral layer, in the center of the casting, forming a parting or crack.

Undoubtedly, the trouble is due entirely to molding practice and it will be necessary to apply the proper measures to correct it. It may be well to consider the following:

The sand was fine to get a smooth casting, it was rammed firmly, so it would not strain and be thicker than wanted. Then a nice solid bottom board was carefully bedded on. So what could the gas do? To help matters probably the drag was quite shallow. We suggest that a thin layer of the fine sand only be used in the drag. Back it up as follows: Mix together new molding sand 10 parts; fine silica sand 5 parts; ground clay, preferably china clay, 1 part, and fill up the drag with it. On this bed a perforated board is used so that the steam can escape as it is generated. In shaking out, separate the drag from the other sand so as not to spoil the entire pile.

Metal Blows on Insert

We are having considerable trouble in trying to cast 85-5-5-5 over a yellow brass of the 64-38-2 composition without having blowholes. We are pouring the metal as cold as possible and still have it run. This temperature is about 2100 degrees Fahr. If we pour the metal hotter so that the yellow brass melts, the castings come out so rough that we cannot use them. When poured at a low temperature the loss runs 30 per cent. We clean the yellow brass turnings and also have heated them or used them cold with the same results. We are using Albany No. 1 molding sand but we do not believe that the sand has anything to do with our trouble.

We agree with you that the sand has nothing to do with the trouble experienced in casting ounce metal over yellow brass. Usually there is more or less trouble in casting brass and bronze onto metal inserts. In the case of iron pipes it is necessary to get them as hot as possible so that they will not cool under 212 degrees Fahr. before the molten metal is poured around them. If the temperature drops, the moisture from the sand condenses on the insert and blows result. In the case of the brass it may be that the zinc fumes given off by the fusing or melting brass causes the blows.

In a recent experience with casting heavy copper castings around thin steel pipes, success was obtained by copper plating the steel tubes. Other methods including coating with tin were tried without results. It may be that this method will help you out of your difficulty. It is costly of course, but if it works, the reduction in casting losses probably will pay for the added cost of copper plating.

Aluminum Is Cause

We make numbers of battery terminals of yellow brass in our jobbing foundry using a mixture of approximately 70 per cent copper; 27 per cent zinc and 3 per cent lead, and we find a considerable percentage of the castings are defective due apparently to zinc oxide originating in the metal, as else some other form of dirt which seems to be deposited in almost the identical spot in each little casting. We are sending a portion of a gate with a couple castings attached.

The dirt and dross is caused by aluminum in the metal. Probably the foundryman adds a couple ounces of aluminum to each hundred pounds of brass as a flux to suppress the fumes and give the metal fluidity, and while it will do this perfectly it is one of those favors that have to be paid for. In the case of these little castings, it is doubtful if the cost imposed by aluminum, does not offset the advantage of the cheapness of the alloy. It is suggested you use the following alloy, which is a cheap red brass, and contains no aluminum, and is not particularly difficult to run, so a loss of 5 per cent ought to be a maximum. The alloy is 77 per cent copper; 14 per cent zinc; 7 per cent lead and 2 per cent tin, with aluminum kept strictly out of it. This is an alloy much used in foundries, and is about as cheap as one can expect to make and obtain the desired red color as distinguished from yellow brass.

Of course the yellow brass at present used can be run minus aluminum but if it is bought in ingots, the chances will favor a content of aluminum. It can always be identified, because the results will always be the same. However, if your are going to continue with aluminum, and your customer will stand for the bright yellow color, why not go the limit in zinc? A suitable mixture is 60 per cent copper; 37 per cent zinc and 3 per cent lead. Add as a flux 2 ounces of aluminum. In casting these aluminized metals you will have better success if the flasks are inclined using a 2 x 4-inch length of wood, placing it under the rear cleat of the flask boards, so the metal will run uphill. Naturally, a ring will have to be put on the sprue to raise it higher, otherwise the mold might not fill.

BILL

By Pat Dwyer

Favors Pop Gates on 8-Inch Pipe

HE SIDLED up to me while the old ware and waking instinct temporarily was relaxed and while I was engaged in the peaceful occupation of gazing at a truly gorgeous display of plants, flowers and crockery in a florist's window. The day was hot, distressingly hot. Intimate contact with the preparation and distribution of molten metal over a period of many years has placed me in a position where I listen with amused toleration to complaints about the heat. A fat lot these complainers know about real heat, the exhausting heat on the charging deck and at the tapping spout, the dripping sweaty heat of the shakeout period, the dry, scorching heat over a feeding head where the feeder's lungs burn and the eyes threaten to ooze out of his head from breathing and blinking air saturated with acrid core smoke at a temperature of —well, I never have seen an actual instrumental reading, but off hand I should say 150 degrees Fahr. is a conservative figure. From the foregoing, the discriminating reader readily will infer that I am not one to raise a needless disturbance about the heat unless this very same identical heat is something worth raising a row about. Therefore, when I say that the day was hot—distressingly hot I believe is the term I used—you are quite safe in placing the most implicit confidence in that statement—the day was too hot even for me.

An indication of the excessive heat is reflected in the fact that I was parked temporarily in front of a flower shop. Ordinarily I might have given the place a glance in passing, but on this occasion the cool, green depths of the window, shaded by an awning and dripping with spray from a miniature fountain combined to set up an attraction I could not resist.

Then—as I believe I pointed out some time back—how time does fly—as I stood there at peace with the world and with the vigilant eye trained solely on the reproduction of a miniature section of the garden of paradise, he sidled up beside me and wanted to know how wus de chances bo for a dime to get a fella a cup a koffy.

I readily can imagine a great many things which a man without funds might desire to purchase, but why he should want to buy a cup of coffee — presumably to drink — at 2:00 p.m., with the thermometer

The Big Scene From "Love's Labor Lost"

sneaking up on the 100 degree mark, imposed too great a strain. On the possible supposition that my ear drums had softened with the heat and therefore were not to be relied upon, I asked him to repeat his request. True, I was startled somewhat by the stealthiness of his approach and I offer that fact—for what it may be worth—in defense of the somewhat abrupt manner in which I said: "Huh?" Just huh, simply that and nothing more.

Dash it all, you cannot expect a fellow to think up something smart and witty when a disreputable form of a human being suddenly materializes beside him and without a word of introduction starts babbling about financial transactions and cups of coffee. Positively weird, I give you my word.

Apparently he did not realize what a start he had given me, sneaking up on his pussy feet like one of these weasel things stalking a rabbit. I suppose I bore some resemblance to a hungry little bunny standing there in front of the window, gazing wistfully at the greenery within.

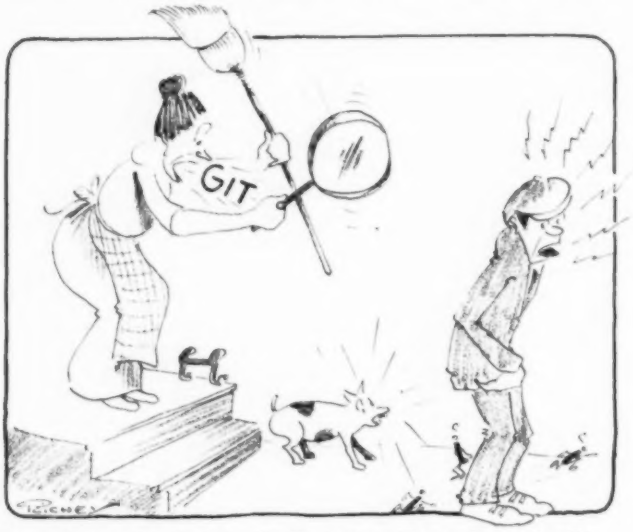
He kindly repeated his original request and then, noting my close attention, he amplified it to some extent by the statement—entirely superfluous if one was to judge by his appearance—that he had not worked for some time.

Had he kept to a reasonable distance, I might—mind you, I don't say I would, but I might have acceded to his request, but unfortunately in his eagerness to impress me with his destitute condition he bent forward closely and confidentially. His breath confirmed a suspicion aroused by the condition of his eyes and the color of his nose. A lighted match applied under his beak would have set him off in a blaze of glory. Under the circumstances, two courses of action presented themselves. I could (a) rebuke him sternly for wantonly and recklessly inflicting a dent in one of the articles of the Constitution duly made and provided to banish the demon rum from this land of the free, or I might (b) appeal to his better nature, plead with him to turn over a new leaf, beg him to turn his back on the wickedness of the city and return to the dear old farm where an aged mother no doubt was waiting for the prodigal to milk the cows, split the wood, plow about 140 acres of bramble infested sticky clay and otherwise while away the weary hours in innocent, bucolic amusement.

Although these two courses of action presented themselves, I did not adopt either. On the first count, why should I condemn in a stranger what I tolerated in a friend or acquaintance? The Federal government paid me no honorarium for snatching brands from the burning. If he wanted to poison the atmosphere with a breath reminiscent of a garbage collection truck, I recognized the fact that he had just as much right on the public highway as that same garbage truck. Those who did not like it or him could pass to windward.

On the second count I readily realized that I simply would be wasting my time. Item 1: If he had any better nature he would not be lurking around corners, popping up suddenly and asking total strangers for dimes and cups of coffee. Item 2. Plead with him to turn over a new leaf. Friend, have you ever heard the allusion to the skin of the ethiopian and

the spots on the leopard? (Note. I wonder who invented that combination for spelling the name of an animal pronounced leperd). Item 3. Back to the land. I doubt if he ever had been nearer a farm than the brake rods, roof or opening in the wall of a side door Pullman. Item 4. Myth of the dear old mother waiting out in the sticks. Any mother seeing this hobgoblin coming down the road would set the dog on him.



Sometimes the Prodigal's Welcome Home Exceeds His Highest Expectations

Instead of adopting either of the two courses of action which logically presented themselves I compromised with my concience and boldly told the lad he was wasting his time—which was worth nothing—and his breath which was worth a fortune if capitalized on strength—by soliciting aid from one who was in the same boat as himself. As a result of my weakness and equivocation in telling him I was doing nothing—the truth of course, but unfortunately not the whole truth—I was treated to an interesting half hour monolog dealing with the life and adventures of our hero. When we finally parted, he was 2 bits to the good instead of the dime he had mentioned in the early negotiations and I suppose the curve showing the consumption of coffee in that city for that particular day, jumped to a corresponding extent.

Accepting my statement that I was—in theatrical phrase—at liberty, he waxed quite confidential and gave it as his candid opinion that he did not know what the world was coming to. He had heard of cases recently where men actually were paying premiums for the privilege of going to work.

"Now," he said in candid man-to-man fashion, with one hairy finger up raised ready to check off the various points as they occurred to him. "Now, ain't dat one hell of a note when a guy has to put up his own dough before he is allowed to go to work? Can ya beat it? Here's one bird what never will submit to no such tyrranical behaviour. It's an outrage, so it is, and sumpin should be done about it. They'll never get nothin out a me, no, sir, not a nickel, not if I don't never get a job again."

I asked him what line of work he followed and was told that he was prepared to tackle almost anything. In fact at one time or another he had turned his hand to practically every form of work which involved no special training period. For several years he had driven a delivery van for a furniture store. "Dat bizness is all shot ta pieces. Nawthin doin' no more. At one time every newly hitched couple needed a whole new outfit of furniture to start housekeepin'. Now dey gits married, hires a couple of furnished rooms for a mont' er two, den the marriage blows up and de *For Rent* sign goes back in de winda. In de good ol' days I made more money in tips dan I did in wages. I was young an' nimble an' tought nawthin of runnin' up tree or four flights of stairs with a chair or a table or the end of a bed. Couldn't do it now. Wind all gone. When I was a young man drinkin' lots of ale, 50 or 60 glass a day, I could run for an hour and breathe just as easy as I am breathing now. Ye kin see fer yerself I breathe jus' as easy as a kid in a crib, but I tink if I wus to run 100 yards now I'd drop dead. No wind any more. All gone." Bill laughed when I told him of the interview. "That lad sized you up for an easy mark," he said. "He knew by your clothes, by your appearance, by your very attitude in dawdling in front of a florist shop that you were not hard up. If you had been hungry he would have found you sniffing the air and gawking in the window of a bakery or a butcher shop. Just to flatter you he pretended to believe your statement that you were idle and then invented the remainder of his story on the spur of the moment when he noticed that you were interested. It is an old stall and I have been told that some gifted lads derive quite an income from its practice.

"There are all kinds of ways of making a living and every one of them has its peculiarities. Even the foundry business is not exempt. In fact I think it presents more peculiarities than any of the others.

"I don't know if the present series of articles on gating in THE FOUNDRY is responsible or not for the inquiry, but I had a letter from a man recently looking for information on the best way to gate a cast iron pipe 10 feet in length, 8 inches diameter, ¾-inch metal thickness and flanged at both ends. He asked if I would advise gating it on top or on the sides at the joint. How many risers are necessary to insure a clean, solid casting to withstand a fairly high pressure. What size core barrel is required and is it necessary to apply more than one thickness of hay rope to the core barrel. He also wanted me to suggest a good loam mixture for the core.

"Taking the questions in the order of presentation I wrote him that the method of gating an 8-inch flanged pipe 10 feet in length simply resolves itself into a question of personal preference on the part of the foundry foreman. Some men prefer to pour castings of this character through a few or several small pop gates on the top, while others favor the more old fashioned method of cutting a row of flat gates at the joint. Where due precautions are observed to keep gates and metal clean, either method will produce satisfactory castings.

"One advantage of the top pouring method is that a much smaller flask may be employed and consequently a saving is effected in the amount of sand and in the time required for ramming the sand. Where the mold is jolted on a machine, or hand rammed by an experienced molder, the danger is minimized but in many instances where these conditions do not obtain, the side gates at the joint introduce a hazardous

—And the Furniture Goes Back To the Cuckoo's Nest

feature. The area of contact between the sand in the cope and the sand in the drag behind the long runner which supplies iron to the gates, is reduced. Frequently this area in the cope has to be repaired either on account of gaggers driven down by the peen end of the rammer, or, because the molder has not rammed it to a sufficient density. In either case, and in his anxiety to prevent a *crush*, the molder makes up the face *a little slack* and as a result an opening is left between the cope and drag faces when the mold is closed. The molten metal squirts through this opening and, usually, the casting is a waster.

"Another point, incident to the side gating method, is known as a *draw*. When the gates are removed, a spongy area, or, in some instances, actual holes varying in size are disclosed in the wall of the casting. Under pressure these areas will leak. This phenomenon, curiously enough, does not appear when the gates are V-shaped, but only when they are flat. For this reason many men are convinced firmly that the thin, flat gate inherently is responsible for this type of defect.

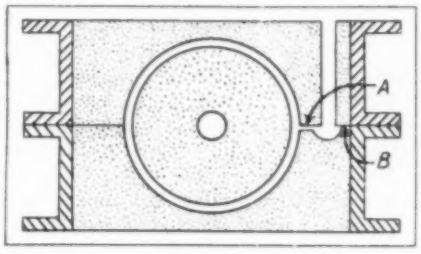
Opinions Vary

"As with many other opinions held by foundrymen, this particular belief is based on insufficient data. The thin, flat gate is employed universally in the production of soil pipe castings. Also it is used successfully in the production of pressure pipe in 16-foot lengths made according to the process in use at the plant of a prominent southern pipe manufacturer. In both of these instances the gates break off clean and the metal in their vicinity is clean, solid and homogenous, a sufficient refutation, if refutation is needed to the belief that thin flat gates at the joint of a pipe poured horizontally, inevitably will cause a *draw*.

"Where a *draw* of this kind appears, it is caused, not by the gate itself, but by the combination of gate and runner. On account of pouring the metal through a single sprue, the runner has to have sufficient capacity to supply all the thin, flat gates. Usually it is greater in cross section than the wall of the casting. At the conclusion of the pouring period it contains iron at a higher temperature than the iron in the casting. The casting solidifies while the metal in the gates and in the casting immediately in front of each gate remains liquid. The metal in the gate then freezes and the metal in the casting immediately in front of it has no further reserve to draw on and the result is a porous spot or the formation of one or more small pipes.

"In some instances the defect is intensified by the inclusion of steam from the narrow dike of sand between the heavy runner and the casting. This form of defect is eliminated by pouring the iron from a multilip ladle into a number of small sprues connected to a continuous or intermittent light runner which discharges metal into the mold through a number of thin, flat gates. The metal in the casting cools uniformly and shrinks in a uniform manner throughout. Taking the proposition by and large, I favor pouring the pipe in question through four ⅝-inch pop gates spaced 18 inches apart on top of the casting and fed from a long basin.

"A single small riser on each flange is sufficient. So far as their efficacy in promoting solidity is concerned, they might be omitted, but they serve a useful purpose in



The Gate Will Draw and the Runner Is To Close To the Flask Wall

showing when the mold is filled with iron and they help to drain the metal out of the pouring basin. The majority of leaking pipes are caused by a boiling action in the iron set up by cores from which the vent does not escape readily through the proper channels. Where the metal lies perfectly quiet in the mold, a solid casting may be expected.

"A single strand of hay rope, or of the special strip pasteboard sold for the purpose and now used extensively, will serve the purpose of facilitating the escape of gas from the core and the removal of the arbor from the casting. A 5-inch diameter barrel with a single thickness of rope or cardboard will serve. With a 4-inch barrel a double thickness of rope will be necessary.

"Without a knowledge of the sand in the vicinity I could not suggest a definite loam mixture. It will be necessary to experiment a little. In a general way it may be stated that any good, open molding sand will make a satisfactory loam core. I suggested that an experimental core be made from the present new sand. Close and intelligent examination after it has dried can determine whether it will serve satisfactorily or not. If it is too hard or too *tight*, he can mix a new batch of sand with a few shovels of sharp sand incorporated in the mixture. The coarser this sharp sand is, the better, of course within reasonable limits. For example, the grains may be as large as match heads.

"If the original core is soft and crumbly, it will be necessary to add a small quantity of binder to the succeeding batch of sand. The binder may be either clay or one of the commercial core binders. In a prominent southern pipe foundry the loam for the cores is made up of a mixture containing 16 parts of old core sand, 4 parts coarse new sand and 4 parts clay prepared under a pair of rollers in a stationary cast iron pan. Water is added until the loam attains the consistency of thick mud.

"In the absence of returned sand from used cores my correspondent will have to adapt his existing ingredients. However, the foregoing mixture will indicate the general characteristics of a mixture at which to aim.

"After he has developed an apparently satisfactory loam mixture I suggested the advisability of placing a core in an open mold or a mold with special large risers where the action of the iron may be watched as it flows around the core. If the iron bubbles, the watcher may rest assured that the vent is not escaping freely through the proper channels and he will find it necessary to *open* subsequent batches of loam with sharp sand, or, reduce the amount of binder."

Institute Will Meet in South Wales

The autumn meeting of the British Iron and Steel institute will be held at Swansea, South Wales from Sept. 29 to Oct. 2. The local reception committee has for its chairman, Frank J. Rees, chairman of the South Wales Siemens Steel association, and Lewis Jones, the secretary of that association, is the honorary secretary of the committee and will act in the same capacity during the meeting.

Two mornings will be devoted to the technical sessions, during which the papers will be presented and discussed. During the meeting, visits will be paid to the Port Talbot and Margam Works of the British (Guest, Keen, Baldwins) Iron & Steel Co., Ltd., the King's Dock Tinplate Works of Baldwins, Ltd., the works of the Grovesend Steel & Tinplate Co., Ltd., Gorseinon, the National Oil Refineries of the Anglo-Persian Oil Co., Ltd., Llandarcy, the Swansea Vale Spelter Works of the National Smelting Co., Ltd., and the Courtybella Works of the Whitehead Iron & Steel Co., Ltd.

William L. Hartley, formerly in charge of the foundry sales division, Link-Belt Co., Chicago, has been appointed district sales manager in charge of the Detroit territory. Mr. Hartley has been associated with the Link-Belt Co. since 1915 and has served in the engineering, contract, standard and estimating departments. The Detroit address of the Link-Belt Co. is 5938 Linsdale avenue.

Gray Iron and Other Metals

Are Affected by Gas

By E. Piwowarsky

IT NO longer can be doubted that metals and alloys take up certain gases in the liquid and also in the solid states. In the case of simple solution, the amount of dissolved gas in liquid metal follows the Henry-Dalton absorption law i. e., the amount of dissolved gas is proportional to its partial pressure. This may be expressed also in the following manner:

At a given temperature the relationship between the concentration of a gas in a gas volume c to that in the liquid c_1 is constant according to the formula: $C_1 \div C = L$. According to Nernst this factor of proportionality L is identified as the coefficient of solubility. If however the molecular condition of the gas is changed by the process of solution then a further extension of the above law is necessary; and individual constants dependent on the molecular condition must be included.

Sieverts, *Zeitschrift fuer Electrochemie*, 1910, found for the solubility m of hydrogen in iron in relation to pressure (p in atmospheres) by constant temperature, the relationship: $m = c\sqrt{p}$ where c is a constant.

Dependence on the temperature by atmospheric pressure gives the relationship according to Fig. 1. That is to say, in the case of a change of the state of aggregation there is a discontinuous change in the solubility, (the alpha to gamma change also is associated with a remarkable alteration in solubility). These solubility effects are to be expected in the changing actions between metals and gases.

Efforts to determine the amount of pure absorption or the absorption accompanied by reaction (change in condition) from the total solubility, were not successful insofar as metals and alloys of high melting point (over about 1300 degrees Cent.) are concerned. This lay in the fact that only recently has it been possible to make use of exact laboratory methods including highly refractory vacuum tubes. The apparatus formerly used for the gas-determination in iron, cast iron and steel, collected the dissolved and reaction gases, including also those expelled as a result of the dissociation of gas-metal compounds, (hydrides, nitrides etc.).

Gases Are Evolved

Piwowarsky, *Stahl und Eisen*, 1920, and other workers have determined the gases evolved during the solidification of pig iron, including carbon monoxide, carbon dioxide and hydrogen, also nitrogen and methane. Results are given in Table I. In this case the gases were collected from the pig iron as poured from the furnace.

Later Piwowarsky and Wuster, *Stahl und Eisen*, 1920, determined the gases evolved in the solidification of phosphorus-rich cast iron using laboratory melts and found the values given in Table II. The high values for methane suggest a secondary action in the volume of the gases recovered. K. Iwase, *Science Report*, Tohoku university, Japan, 1926, found as a result of equilibrium experiments between hydrogen and different metals the solubilities given in Fig. 2. The form of the curve can be compared with the results of Sieverts although not in the quantitive sense.

Although it has not been possible to confirm the existence of hydrides of iron metallographically, nitrides of iron and accompanying elements, (the nitrides of manganese, silicon, aluminum, chromium and titanium) have been observed many times. The stable nitrides of iron and titanium (at 1700 degrees Cent. and above) are present as square inclusions of reddish color on the unetched, polished surface, these may be numerous in some pig irons.

Iron nitride (Fe_2N) itself is only stable below about 400 degrees Cent. according to Tschischewsky, *Stahl und Eisen*, 1916. Nitride of manganese is

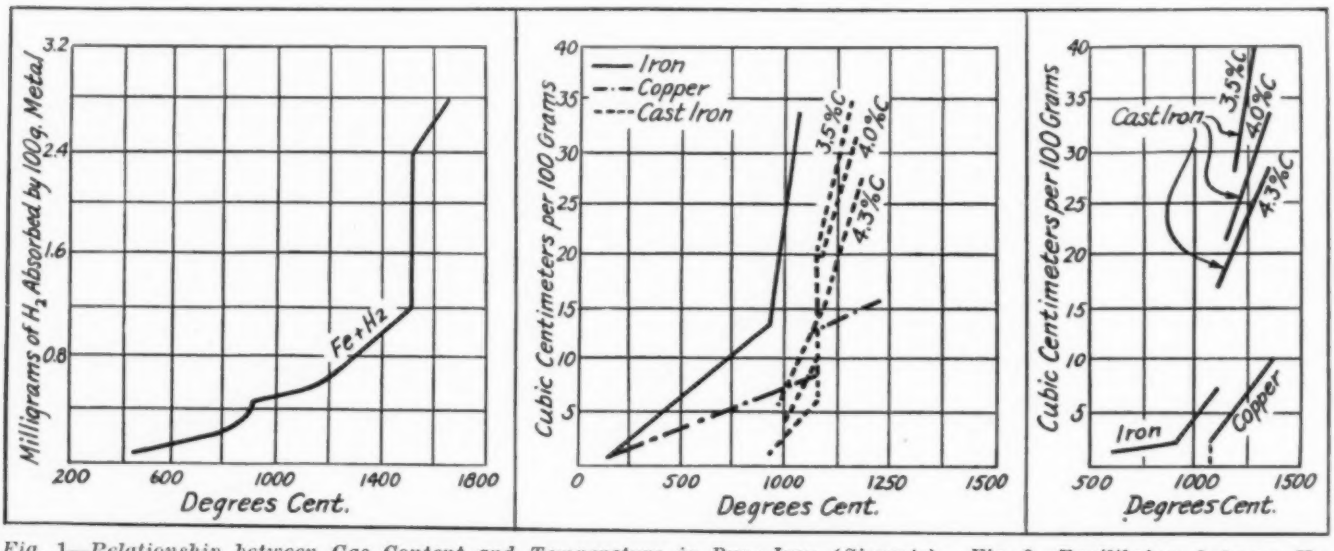


Fig. 1—Relationship between Gas Content and Temperature in Pure Iron (Sieverts). Fig. 2—Equilibrium between Hydrogen and Different Metals with Increasing Temperature (Iwase). Fig. 3—Equilibrium of Nitrogen with Solid Iron, Molten Copper and Gray Iron (Iwase)

much more stable and the nitride of silicon stable up to 1600 degrees Cent. Tschischewsky gives a higher stability for the nitride of aluminum. Quieting action of metallic silicon and aluminum on solidifying baths of iron is due partly to their ability of combining with dissolved nitrogen. Fig. 3, according to Iwase gives the equilibrium of nitrogen with solid iron as well as liquid copper and cast iron on the supposition that no nitride formation takes place.

Oxygen is present in liquid iron often as ferrous oxide, or combined with other elements commonly found with iron (Mn, Si, Al, Ti, Va, etc.). It also is present as carbon monoxide and carbon dioxide insofar as they are soluble. Large quantities of CO and CO_2 which escape during the solidification of all the different types of commercial iron and which are the cause of porosity and blow-holes, owe their origin to a reaction between the metallic oxides present and the carbon rather than to simple giving up of the dissolved gases.

Oxygen Is Dissolved

It was possible only by this means to estimate the amount of oxygen from the determined reaction gases CO and CO_2 in the method of Oberhoffer, *Stahl und Eisen*, 1922 and 1924, for the determination of gas in the presence of superfluous carbon. Pure iron dissolves just above the melting point, some 0.2 per cent oxygen, as shown by Table III.

It may be assumed that the amount of dissolved oxygen would decrease with increasing carbon, since according to the equation

$$FeO + C = Fe + CO \qquad (I)$$

a part of the same is reduced (Fig. 4). Since in the liquid iron, carbon is dissolved probably as carbide, and it is known that under atmospheric pressure a complete removal of the oxygen (deoxidation) from the iron is impossible, for apparently an equilibrium between the reactive substances sets in, then the course of the change according to equation (I) is written more suitably

$$Fe_3C + FeO + 4\ Fe + CO - 20{,}900\ \text{cal.} \quad \text{(reversible)} \qquad (II)$$

Assuming that before the oxidation the bath is supersaturated with FeO, one may write (Fe assumed constant)

$$\frac{{}_pCO}{(Fe_3C).(FeO)} = K \text{ or } \frac{{}_pCO}{(C).(FeO)} = K \qquad (III)$$

where K increases with the temperature (principle of least force). That is, deoxidation by means of carbon is favored by increasing temperature (Fig. 4), at the same time the amount of dissolved gas (CO) at equilibrium must decrease. Iwase actually found during his investigations on equilibrium in CO-rich (85-98 per cent) $CO+CO_2$ gas mixtures a decrease in the amount of gas with rising temperature. This is shown in Fig. 5. Increasing carbon content of decreasing quantities of gas agree with Equation III. Nevertheless one must remember that in the apparently high values for the absolute quantities of gas in Fig. 5, a latent quantity of gas due to the coexistence of carbide and oxide is included.

Removal of the gas phase, for example, deoxidation with carbon in vacuum must lead to the complete removal of oxygen according to Equation III (ideal deoxidation).

When conditions according to Equation III are difficult to obtain on a commercial scale it may be said that carbon-rich irons must be less absorb-

Table II

Vacuum Absorption of Gas in Cast Iron

Analysis of cast iron: T.C. 3.36%; Gr. 1.41%; Si. 1.36%; P. 0.029%; S. 0.018%

Number	Temperature of Melt Deg. Cent.	Amount of Gas in 100 gm. cast iron c.c.	Gas Composition—Volume Per Cent CO_2	N_2	H_2	CO	CH_4
1	1280	6.93	5.51	25.20	39.60	20.42	9.42
2	1340	4.96	14.30	18.66	31.99	24.18	10.90
3	1370	4.78	12.33	15.30	31.60	29.90	10.88
4	1390	....	11.45	11.11	41.81	22.24	13.38
5	1410	8.07	7.62	12.57	32.98	24.00	22.83
6	1440	6.93	12.50	13.40	32.34	29.28	12.50
7	1490	8.71	13.12	15.75	29.67	29.67	11.81
8	1520	8.90	9.36	20.43	36.81	26.61	6.73
Analysis of cast iron: T.C. 3.25%; Si. 1.90%; P. 0.038%; S. 0.03%							
1	1580	8.32	21.44	12.04	28.00	28.42	10.07
2	1570	5.78	17.70	13.80	33.60	23.05	11.91
3	1510	4.84	14.70	13.11	34.65	30.43	7.08
4	1500	5.67	14.60	12.98	34.70	24.32	13.22
5	1400	7.41	16.00	13.88	35.49	23.76	10.93
6	1340	5.36	16.93	20.00	32.38	20.91	9.85

The melt first was heated to about 2900 degrees Fahr.; then cooled to the temperature given and the gases absorbed in the evacuated flask.

Phosphorus-rich cast iron superheated to different temperatures

Analysis of cast iron: T.C. 3.24%; Si. 1.26%; Mn. 0.40%; P. 0.94%

1	1270	4.89	8.82	19.00	63.85	2.85	6.08
2	1280	7.41	5.51	25.20	39.60	20.42	9.24
3	1300	4.50	14.90	23.42	36.20	15.33	9.36
4	1320	6.03	18.12	8.74	18.00	47.00	8.15
5	1340	5.35	14.30	18.66	31.99	24.18	10.90
6	1345	6.65	14.78	18.48	42.80	11.08	13.02
7	1350	4.39	20.31	10.62	33.31	27.28	8.48
8	1370	5.17	12.33	15.30	31.60	29.90	10.88
9	1390	9.56	13.12	15.75	29.67	29.67	11.81
10	1400	5.56	19.25	15.40	25.63	31.53	8.20
11	1410	8.60	7.62	12.57	32.98	24.00	22.83
12	1435	9.84	15.90	7.94	40.50	26.20	9.54
13	1440	9.10	18.06	15.30	27.80	32.32	6.39
13a	1440	7.70	12.50	13.40	32.34	29.28	12.50
14	1500	4.70	16.09	9.70	38.72	27.20	8.25
15	1520	9.70	9.36	20.43	36.81	26.61	6.73
16	1570	6.50	17.70	13.80	33.60	23.05	11.91
17	1600	5.30	14.70	13.10	34.60	30.40	7.08
18	1600	4.02	12.11	8.46	41.10	32.10	6.20
51*	1500	10.12	13.40	9.52	27.08	42.40	7.57
52**	1500	6.97	8.98	11.54	37.40	31.02	11.03

*Swedish pig iron.
**Swedish pig iron plus 0.8 per cent phosphorus.

Table I

Gases in Pig Iron Specimens

Test No.	Pig Iron Mn	P	S	Si	Gases Evolved CO_2	CO	H_2	N_2
	Per Cent				Per Cent			
1	1.69	2.11	0.065	0.35	0.84	24.00	30.80	44.26
	Sample taken soon after the commencement of tapping				0.40	28.20	39.30	31.80
					0.40	31.40	46.00	21.90
					0.60	30.80	49.60	18.60
					0.85	29.40	47.30	22.15
11	2.01	2.35	0.065	0.45	0.74	36.40	42.83	19.80
	Sample taken about the middle of tapping.				0.45	39.49	47.23	12.63
					0.55	38.86	49.69	9.76
					0.55	39.62	48.02	11.54
					0.57	41.90	46.22	11.15
111	1.90	2.23	0.065	0.41	0.40	43.30	45.80	10.50
	Sample taken towards the end of tapping.				0.35	43.90	44.10	11.55
					0.30	42.20	48.30	9.10
					0.35	43.00	45.20	10.55
					0.48	40.70	46.20	12.52
	Analyses a:				0.30	0.80	2.10	Rest
	b:				0.30	0.95	1.80	Rest

Table III

Oxygen in Iron

Investigator	Oxygen per cent	Observations
Austin[1]	0.28	Temperature not given
Bureau of Standards[2]	0.21	At melting point
Tritton and Hanson[3]	0.21	At melting point
Herty[4]	0.27	Above melting point
Herty[4]	0.22	At melting point

[1]J. Iron Steel Inst. 92 (1915) p. 157.
[2]Chem. Met. Engg. 26 (1922) p. 778.
[3]J. Iron Steel Inst. 109 (1924) p. 90.
[4]Trans. Am. Inst. Min. Met. Engs. 73 (1926) p. 1107.

ent for oxygen than either soft iron or low carbon cast iron, and further in a similar way, also tends to formation of blowholes sometimes found in iron castings.

When an iron-carbon alloy containing oxygen after a certain superheating temperature has reached the state of equilibrium according to Equation III and starts to cool, then cooling takes place in the melt at first without evolution of CO, since according to the principle of least force the direction of the reaction in Equation II is towards the left. That is a decrease in the amount of dissolved CO in coexistence with oxide and carbide is to be expected. On commencement of solidification then pure iron crystals or relatively pure solid solution separates out according to the carbon content and in this way the iron concentration cannot be held constant, and equation III changes to give the following formula for the constant:

$$\frac{p_{CO}\,(Fe)^4}{(Fe_3C).(FeC)} = K \qquad (IV)$$

It now becomes clear that crystallization of the iron-rich solid solution by decreasing the (Fe) must lead to a decrease of the denominator in Equations III and IV with formation of CO, until the steel or the cast iron (carbon below the eutectic composition) is solidified completely. This reaction,

Table IV

Analysis of Specimens

No.	Carbon	Silicon	Manganese	Phosphorus	Sulphur
G 85	3.38	1.75	0.38	0.39	0.06
P 85	3.28	1.35	0.70	0.45	0.08

Porosity in Per Cent

	1.18-inch piece		2.36-inch piece	
	Cube A	Cube B	Cube A	Cube B
G 85	0.92	1.02 0.61	0.98	1.32
P 85	0.41	0.61	0.50	0.65

Table V

Composition of Metal

No.	Carbon	Silicon	Manganese	Phosphorus	Sulphur
G 18	3.30	1.65	0.85	0.40	0.08
P 18	3.21	1.15	0.87	0.36	0.06

the cause of the rising of the steel during its solidification, apart from alteration of the quantities of dissolved nitrogen and hydrogen, is also primarily responsible for the formation of blowholes in solidifying cast irons.

All measures which help to reduce the concentration of dissolved oxygen carried in the molten iron must lead to an improvement in deoxidation and increase of the specific density. It is general that a metal possesses greater solubility for its own oxides than for the oxides of other elements and the same holds for the sulphides. On the other hand, since manganese, silicon, aluminum, vanadium, titanium, etc., possess greater affinity for oxygen than iron, it is possible to employ these elements as deoxidizers.

Considering the case of deoxidation with manganese,

$$FeO + Mn = MnO + Fe + 25{,}800 \text{ cal.}$$
(reversible),

the equation must lead to an equilibrium, since a complete deoxidation with manganese is not possible according to experience. This compels one to assume a partial (if ever so small) solubility of the MnO in liquid iron. The mass law for constant temperature demands (the concentration of the iron present in the surplus regarded as constant)

$$\frac{(FeO)\,(Mn)}{(MnO)} = K \qquad (V)$$

where K increases with the temperature. That is, regarding Equation V alone, the deoxidation with manganese would have to follow suitably with lower temperature of the iron which is in the bath.

In a similar way considerations in the case of desulphurization, as long as the maximum concentration of the dissolved oxygen is not reached, according to the distribution constants of Nernst, oxygen is distributed in the bath and slag according to the equation,

$$L_{FeO} = \frac{(FeO)}{(O)_{Fe}}$$

Therefore complete deoxidation is not possible as long as the slag exhibits free and dissolved oxides or oxides liberated as a result of dissociation for which the bath of iron also

(*Continued on Page* 53)

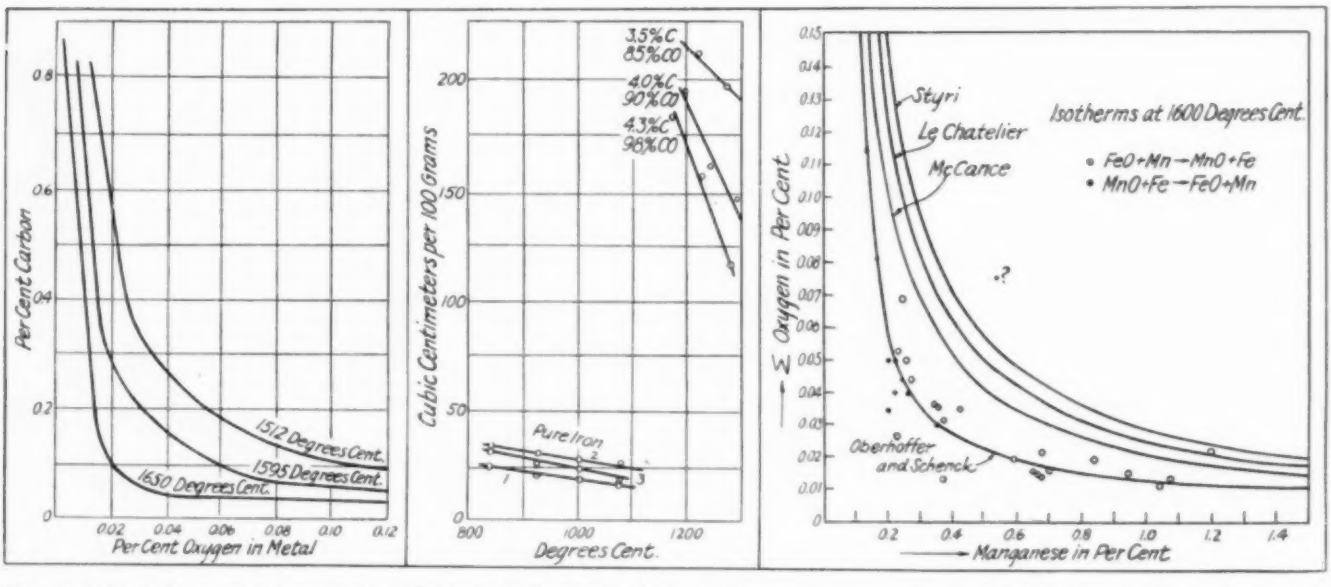


Fig. 4—Equilibrium of Oxygen with Carbon in Iron at Different Temperatures. Fig. 5—Equilibrium between Solid Iron or Gray Iron and CO-rich Gas Mixtures with Increasing Temperature. Fig. 6—Equilibrium between Oxygen Dissolved and Iron Containing Manganese

The FOUNDRY Family Photograph Album

Photo Blank & Stoller

Upper Left

VAUGHAN REID
City Pattern Works, Detroit

Upper Right

CARL CASBERG
University of Illinois, Urbana, Ill.

Lower Left

L. P. ROBINSON
Werner G. Smith Co., Cleveland

Lower Right

L. N. SHANNON
Stockham Pipe & Fittings Co., Birmingham, Ala.

TENTATIVE RECOMMENDED PRACTICE FOR

Manganese Bronze Alloy

(*Continued from Data Sheet No. 872*)

Cores

The high strength of the alloy permits the use of strong cores without danger of developing excessive strains in the casting while hot. The use of silica sand with a good grade of core oil is suggested. Blacking with graphite is practiced on most work to assist in the removal of cores from castings, the finish, however, being good on untreated cores. Due to the high shrinkage, chills are frequently imbedded in dry-sand cores on work of irregular section to prevent local shrinkages. The regular practice as to venting and reenforcing apply to this alloy.

Molding Precautions

Manganese bronze is characterized by very high shrinkage and a tendency to form dross when agitated. Castings should be designed with as uniform cross section as possible. Where this is impractical, generous fillets should be provided at section junctions and the heavier sections either chilled or well fed. The drossing tendency makes necessary special precautions in the gating of this alloy, in order to prevent dross inclusions in the casting generated by turbulence at the entry. Clean castings are successfully made by filling the mold by simple displacement, as in bottom pouring, or any other method whereby the velocity of the stream from the gate is reduced to a minimum. Choke gates, strainer cores, and pouring basins are successfully used to prevent entry of dross from the ladle.

Melting

This alloy is melted in all the common types of furnaces. Due to the low boiling point of zinc, close control of the melting equipment is necessary to maintain uniformity of product. Fluxes are useful on all forms of melting of this alloy to retard the vaporization of this element. Soda ash in particular is recommended.

(*Concluded on Data Sheet No. 874*)

TENTATIVE RECOMMENDED PRACTICE FOR

Manganese Bronze Alloy

(*Concluded from Data Sheet No. 873*)

The superheat required on this alloy is very low; a pouring temperature of 1832 to 1922 degrees Fahr. will suffice for all work. Additions, to compensate for selective melting losses, are made at the end of the melt. No deoxidizer is required, the alloy being thoroughly deoxidized by its own constituents.

Impurities

(a) *Lead* is the chief impurity found in manganese bronze. In large castings, or in castings that are likely to be highly stressed, it is recommended that a maximum of 0.20 per cent be permissible. There is no question but that lead has a deleterious effect on mechanical properties and shock resistance in particular, an effect which may be greatly exaggerated by segregation of the lead in large castings. For castings unlikely to meet severe stresses, an upper limit of 0.5 per cent lead is not excessive. There is a possibility of buying extra high-grade zinc which carries practically no lead and which, if used, will produce a manganese bronze with such a low lead content as to improve materially the elongation and also some other characteristics of the alloy.

(b) Although *Tin* has been regularly used as a constituent of this alloy from its inception, there is evidence now to show that it may exercise an evil effect if carried to a slight excess. Some investigators suggest dispensing with it altogether, and, inasmuch as the lately developed super-high-tensile brasses contain no tin, it would seem advisable in most cases to hold it within low limits—0.50 to 0.75 per cent. However, in some cases a tin content up to 1.25 per cent is not only permissible but desirable, to increase the rigidity of the alloy and consequently influence the yield point, and is beneficial for a certain class of castings.

Revisions

The Committee on Recommended Practice expects to make additions, corrections and revisions from time to time as the increased information becomes available.

The Foundry Data Sheet, Aug. 15, 1931

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

(*Continued from Page 50*)

possesses a certain solubility (FeO, MnO, etc.).

Therefore it is necessary:

(a) To obtain the most thorough reduction of the dissolved iron and manganese oxides in metallurgical operations with lime-rich silicate slags (basic, open-hearth, air or electric furnace) by refining in reducing flame, the use of ferrosilicon, or covering of the hearth with coal to prevent access to air.

(b) To restrain the dissociation of the iron and manganese silicates by means of a large surplus of silica as far as possible in melting furnaces with acid working slags (acid hearths).

It appears, that in the experimental examination of the equilibria in the deoxidation with manganese the bath contains smaller quantities of oxygen than would be expected from the equation

$$FeO + Mn = MnO + Fe \text{ (reversible)}$$

Fig. 6 shows the experimentally determined curve of Oberhoffer and H. Schenck, *Stahl und Eisen*, 1927 as compared to the calculated isotherms at 1600 degrees Cent. of Styri, *Journal*, Iron and Steel institute, 1923, Le Chatelier *Revue Metallurgie*, 1912 and McCance, Transactions, Faraday society, 1925. One assumes from the work of Oberhoffer and Schenck, *Archiv fuer Eisenhuettenwesen*, 1928, that the deoxidation product in the treatment of iron with manganese is not pure MnO, that moreover the latter, since it apparently possesses a certain solubility for FeO, is the last which separates out from the bath as a result of the end conditions of separation according to Nernst's distribution law.

If this takes place, then the deoxidation must be also more favorable with increasing MnO content in the furnace slag, because the free FeO is brought into a less soluble condition in the bath of iron. J. M. Gaines, *Blast Furnace*, 1928, actually found in determining the distribution constant

$$L_{FeO} = \frac{(FeO)}{(O)\ \text{Summation}}$$

using some of the metal and slag analyses of Oberhoffer and Schenck and some equations of Schenck, a strong increase for L FeO with increasing MnO content in the slag. Herty and Gaines have found L FeO to be 339 for a slag containing no MnO and almost exclusively consisting of FeO according to *Bulletin* 34, Carnegie Institute of Technology, 1927.

Strong increase of the distribution constant L FeO with increasing MnO content in the slag indicates that in relationship

$$L_{FeO} = \frac{(FeO)}{(O)\ \text{Summation}}$$

with rising MnO content the denominator (O) Summation becomes smaller as a certain part of the FeO in the slag and is prevented by the MnO from passing into the metal bath. Gaines terms this inactive. This agrees with the observation of Oberhoffer and Schenck that the oxide mixture is less soluble in iron as the MnO content becomes greater.

Gaines attempts a numerical consideration of this by a further valuation of the tests of Schenck. With the aid of the time-equilibrium constant

$$K = \frac{(O)_{Fe} \cdot (Mn)}{(O)_{Mn}} = 1.82 \text{ (According to Oberhoffer and Schenck)}$$

he determined the oxygen combined with iron in the metal from the total oxygen and manganese contents to be:

$$(O)_{Fe} = \frac{1.82\ (O)\ \text{Summation}}{(Mn) + 1.82}$$

Using the equation

$$L_{FeO} = \frac{(FeO)\ \text{active}}{(O)_{Fe}} = 339$$

(according to Herty and Gaines) he determined the equation for the

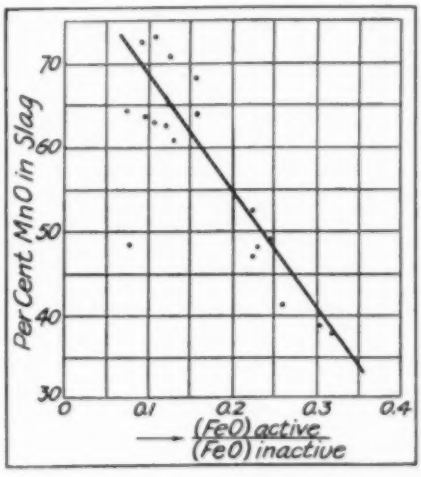


Fig. 7—Increase in the Activity of FeO with Increasing MnO Content

active content of the slag as follows:

$$(FeO)\ \text{active} = 339.\ (O)_{Fe}$$

This is small in comparison to the inactive FeO content, and according to Gaines is the amount of FeO bound by MnO. With falling MnO content of the slag the relationship is

$$\frac{(FeO)\ \text{active}}{(FeO)\ \text{inactive}} = 0.073 \text{ to } 0.466$$

Fig. 7 shows a linear reduction in

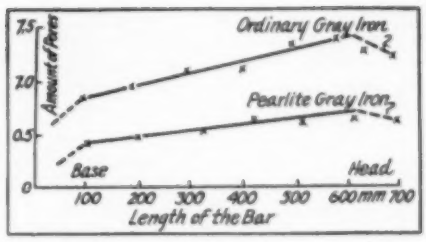


Fig. 8—Comparison between Densities of Ordinary Gray Iron and Pearlitic Structure Gray Iron

this relationship, that is a decrease in the activity of the FeO with increasing MnO content of the slag. In line with these considerations it may be called to attention that one does not like to go below a certain MnO content in the slag when working in the acid, open-hearth furnace with quality steel.

Relationships Are Complicated

Qualitative consideration of these relationships becomes advantageous for the deoxidation process in the case of cast iron (in the heated fore-hearth, air or electric furnace), although as a result of the high carbon content which on the one hand causes reduction of the available free iron at disposal and the formation of manganese carbide on the other hand, alters and helps to complicate the quantitative relationships in similar sense. Ideas developed here are applicable also for the course of deoxidation with silicon aluminum, titanium, vanadium, etc. It must be observed, however, that the solubility of their deoxidation products in iron is probably smaller than those of MnO. Moreover as they are more stable and more difficultly reduced, reduction of their oxides (SiO_2, Al_2O_3 TiO_2, etc.) will proceed parallel to the course of the Equation IV with less speed during the period of solidification.

Also a coagulation of the deoxidation products (helped by movement) is always favorable in deoxidation through an improvement in the possibility of formation of easily liquified silicates or aluminates, etc. (deoxidation with ferromanganese-silicon, etc.) Here the time factor plays a conspicuous role. (Allowing to stand, centrifugal separation, etc.).

There is little literature of importance, other than the work of J. Johnson Jr., *Stahl und Eisen*, 1918, on the

Table VI

Ratio of Oxides

Test	O Per cent	Mn Per cent	FeO Per cent	MnO Per cent	L FeO
R 18	0.115	0.13	74.5	25.5	.....
R 21	0.150	0.22	63.5	36.5	375
R 15	0.044	0.24	61.5	38.5	635
R 14	0.040	0.26	59.6	40.4	810
R 16	0.030	0.35	52.2	47.8	1050

effect of single gases on the mechanical properties of cast iron. The opinion of Johnson that an increased oxygen content in cast iron results in an increase in strength still requires direct proof. Relationships between the oxygen content and mechanical properties as given by Oberhoffer, *Stahl und Eisen*, 1914, and his co-workers were the result of an error and a failure in the determination of the oxygen.

Graphite Absorbed Air

In the latter case milled cuttings were employed for the determination. The graphite in the cuttings absorbed air, which was not expelled entirely at room temperature in vacuum but was expelled in the heating process during the gas determination. The finer the graphite, the greater the ability for absorption, and the value for the oxygen accordingly became greater. The reaction of the oxygen on the graphite size and fineness (according to Oberhoffer and co-workers) is not admissable. It is better to say that the increasing fineness of the graphite brought about the erroneous and high oxygen content which was determined.

Alterations in the mechanical properties found by Oberhoffer and his coworkers were the result of two interconnected factors, namely the reduction of the graphite size and the casting temperature (which altered by that experiment). This explanation for the above relationship has led to the use of compact pieces for the oxygen determination. The oxygen content in cast irons so far as it could be estimated has been shown to lie between 0.001 and 0.04 per cent. Meanwhile, improved methods of determination of residues of the gas and oxygen contents, *Archiv fuer Eisenhuettenwesen*, 1828, includes the method of determination of residues, *Stahl und Eisen*, 1927, (SiO_2 Al_2O_3 and eventually FeO) will permit in the future a correlation of the factors mentioned.

The author has been able as the result of a long series of unpublished experiments, to prove the favorable effect of a deoxidation of cast iron before casting. An addition of 0.05 to 0.15 per cent silicon as ferrosilicon or aluminum-silicon to types of iron with a bending strength from 68,271 to 73,960 pounds per square inch regularly resulted in an increase in bending strength to 73,960 to 82,494 pounds per square inch.

Cast irons which have been melted hot always require an end treatment with some silicon, aluminum, titanium or vanadium to obtain dense castings free from blowholes. The author also has observed that melts containing nickel show less tendency to form blowholes. In the case of comparison melts it was possible without knowing the analysis, to point out immediately the pieces containing nickel due to their clean and fine grained fracture and the clean surface of all the test pieces.

Specific gravity (compare with *Giesserei Zeitung*, 1928) of different cast irons ranges from 6.8 to 7.5 according to the carbon, silicon and graphite content, and is affected partly by the microscopical and macroscopical porosity. Hotly melted cast iron, free from blowholes, is considerably denser than often imagined. By interposing a 0.02 to 0.08-inch strong cast iron plate between a pressure of 150 to 175 atmospheres (2200-2500 pounds) of hydrogen on one side and vacuum on the other side, E. Piwowarsky and H. Esser were able to observe no or only slow increase of pressure in a sensitive vacuum meter not only when better quality cast irons but also when pig or coarse graphitic cast iron were tested.

F. Roll, *Giesserei Zeitung*, 1927, examined the porosity of cast iron by the dye pressure method. Cast iron sections, 1.18 or 2.36 inches long and 1.57 inches wide were inserted in the free space of a steel cylinder provided with closely fitted end pistons. A 1/100 to 1/500 normal fuchsin or eosein solution in water was then poured in and placed under a hydrostatic pressure of 200 to 2000 atmospheres (2940 to 29,400 pounds) for 10 to 30 minutes. The dye solution is forced into the pores and fine channels. The testpieces are finally removed, dried, turned as carefully as possible in a lathe, and tested for color intensity by comparing against a solution of known color strength.

Coloring Matter Absorbed

Table IV shows the superiority of a pearlitic structure casting (P 85) against ordinary gray cast iron (G 85); Fig. 8 shows the same conditions with two types of iron whose analyses are given in Table V. The greater density of the lower end of the test pieces due to ferrostatic pressure should be noted.

Roll's test does not refute the experiments of Piwowarsky and Gesser, as probably the results of Roll are in error caused by absorption of the coloring matter by the graphite. The macroscopical examination for cavities and coarse porosity by means of the *K*-test bar advocated by Cook should give good service in practice. Reference already has been made to the importance of included or dissolved gases on growth of cast iron.

We find the appearance of the so-called nodules due to sweating in phosphorus-rich cast iron favored by the increased specific density as the contraction then leads to a partial pressing out of the still liquid ternary phosphide components which finally solidifies about 950 degrees Cent. Chemical analysis of such nodules is approximately that of the phosphide eutectoid (7 per cent phosphorus and 2 per cent carbon).

Specific density of liquid cast iron at 1450 degrees Cent. follows somewhat the following relationship according to H. A. Schwartz, *Industrial and Engineering Chemistry*, 1925, $d = 7.16 - (0.1\ Si + 0.07\ C)$.

Quad-City Directors Hold Meeting

The first meeting of the new board of directors of the Quad-City Foundrymen's association was held recently at the LeClaire hotel, East Moline, Ill. Those present were E. A. Gullberg, president of the association, Charles Scherer, vice-president; P. T. Bancroft; A. E. Hageboeck; John H. Ploehn; R. W. Eichman; F. W. Kirby; E. W. Rice and S. M. Brah, secretary.

The following program was planned for the coming season: September meeting will be addressed by M. J. Gregory, factory manager, Caterpillar Tractor Co., Peoria, Ill., on general foundry practice; October meeting will be devoted to steel practice and the speaker will be H. P. Evans; Hyman Bornstein, Deere & Co., Moline, Ill., will talk in November on the feeding of castings. Several speakers including Mr. Pyle, Muskegon, Mich., R. M. Scott, foundry manager, Packard Motor Co., Detroit, and Mr. Babo, Dodge Bros., Detroit or Vaughan Reid, City Pattern Works, Detroit, will speak to the association at the December meeting on patterns. The speakers will stress the importance of well designed core prints, core boxes, and the elimination of dryers in the core room.

The first meeting of 1932 in January will be devoted to scientific price setting. The speaker has not been selected for that meeting. Carl Joseph, metallurgist, Saginaw Malleable Iron division, General Motors Corp., Saginaw, Mich., will address the February meeting on malleable iron. The subject for discussion at the March meeting will be gray iron as an engineering material. Oliver Smalley, technical director, Gray Iron institute, Cleveland, will be the speaker. April meeting will deal with high-test iron. Two speakers have been selected. They are Duncan Forbes, Gunite Corp., Rockford, Ill., and D. J. Reese, Whiting Corp., Harvey, Ill. The former will discuss the special iron made by the company with which he is affiliated and the latter will describe the operation of a rotary, pulverized-coal-fired furnace. The meeting in May will be devoted to electric furnace iron and H. E. Bromer, Standard Foundry Co., Racine, Wis., will be the speaker.

A. D. Matheson was appointed chairman of the membership committee.

His Hobby Is Making Strong Iron STRONGER

AFTER spending nearly 40 years in the intimate investigation and improvement of cast iron, Ralph S. MacPherran, in charge of the chemical and physical laboratories of the Allis-Chalmers Mfg. Co., Milwaukee, came out flat footed recently and declared for the benefit of all and sundry who care to listen, he is firmly convinced that following the lead of steel, we soon shall develop the use of quenched and tempered alloy cast iron.

"Oh, yeah," we hear some doubting Thomas say in accents anything but mild, "And who is this McPherrous guy and what does he know about it?"

Ferrous Not Far Wrong

The name, friend, is not McPherrous, although the guess is not so far astray, considering the prominent part ferrous material has played in his life work, and conversely, the profound changes that have come about in many sections of the industrial field, as a result of his thought, effort and experiment. Upon looking closely, you no doubt will perceive that the name is MacPherran with the Mac spelled out properly after the Highland manner and with two *r*'s in the Pherran. The elasticity of these two letters simply is marvelous. In Milwaukee the sound of two is combined as one. In Aberdeen the birthplace of Mac's first ancestor to come to America, the *r* with characteristic generosity is amplified to several times its original dimensions.

Furthermore, if doubting Tommy was posted on current events, if he was following current technical literature, if he knew who was who in the metallurgical field and what is he doing, finally, if he had attended the banquet at the recent A.F.A. convention in Chicago and heard Fred Erb in neatly turned phrases present the J. H. Whiting gold medal to Ralph Stewart MacPherran for his many valuable contributions to the foundry industry, if the aforesaid Tommy was in any of the foregoing positions, he would have been saved the humiliation incident to the hypothetical *faux pas* of the second paragraph.

And that—if one may be pardoned for adopting the argot of the interrogater—is that!

Mr. MacPherran was born Feb. 1, 1871, at Sterling, Ill., and received his higher education the first year at the University of Wisconsin, Madison, Wis., and the remainder at the University of Michigan, Ann Arbor, Mich., from which he was graduated in 1892 with the degree of Bachelor of Science in chemistry, with a firm belief that Michigan is "Peer to any school, highland or lowland, far or near," that with a fair field and no favor—or crooked work—its football team cannot be beaten, that yellow and blue have all the other primary colors washed from the spectrum and that the old school song by the same title is the only one capable of rousing every emotion from tender sentimentalism to the resolve to die if needs be for the good old name. Hail! Hail!

The Yellow and Blue

Oompah, oompah, oompah! Yellow the fields where ripens the grain, oompah-oomp and yellow the moon on the havest wain. Boom, boom on the big drum. The mob of 100,000 is on its feet swaying to the oompah-oomp and roaring, "Blue are the blossoms to memory dear," oompah, oompah, oompah, oomp, "and blue is the sapphire that gleams like a tear. Hail! Hail, to the ribbons that nature has spun. Hurrah for the yellow and blue." Oompah, oompah, oompah, oomp!

Mac goes back to attend one of the big games every year to critically appraise the old fighting spirit, to hear the band and the cheering, to talk about *our* team and to recapture again for a brief period the enthusiasm that was his when he was 21 and stepping out from under the fairy aegis of the yellow and blue to engage in the plebian task of looking for a job.

Noted Foundry Metallurgist

He found one with the Illinois Steel Co., and remained for three years in the Joliet and South Chicago works. In 1895 he joined the staff of the E. P. Allis Co., Milwaukee, one of the first firms in this country to introduce chemistry to the foundry. For a period of a year, from June 1907 to June 1908, he was in charge of the laboratory of the J. I. Case Threshing Machine Co., Racine, Wis. Then he returned to the Allis-Chalmers Mfg. Co., successor to the E. P. Allis Co., and has remained there to date.

In his term of service he has seen the fracture test of iron yield to the chemical analysis and mechanical physical test. In recent years he has contributed notably to the development of high test and alloy cast iron and—as was said in the beginning—he now is hot on the trail of quenched and tempered alloy cast iron.

Mr. MacPherran is a member of the American Foundrymen's association, the American Society for Testing Materials, the International Society for Testing Materials, the American Chemical society and the American Society for Steel Treating.

In early life (believe it or not) he was told that girls did the asking. He still is waiting for one to ask him. Then he'll probably say NO. The old iron will, tensile 80,000, transverse 4999 and brinell 587!

DAN M. AVEY
Editor

The Shakeout

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Managing Editor

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EDWIN BREMER
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¶ Who Is YOUR Banker

ANY buyer who asks and receives undue credit extensions, makes a banker of the seller. Therefore, the foundry which acquires a new customer, or retains an old one whose allegiance is threatened, by extending long credit is launching forth in the banking business. But who wants to be a banker, these days? Evidently, the paths of finance are not all rose bestrewn—or why should so many bankers venture into manufacture and commerce, by seeking seats at the directors table or placing managers in charge of businesses to which they have extended credit.

TO REVERT to a more serious view, no foundry can afford to loan working capital to customers, even on as good security as castings made in the foundry's own shop. A buyer of castings who uses pressure to obtain excessive credit terms, is cutting the price on every casting that he buys and without the consent of the seller. Regular terms, established in times of normal business should govern. Save the working capital for purposes more valuable to the success of your own business.

¶ Confidence Builds Confidence

DISTRIBUTION of information, once a slow and painful process, now is turned to the swift and modern tempo. The press and the radio do their share, aided by the greatest agency of all, known across the ocean by the dignified title of cinematograph and on this side by the more familiar and abbreviated *movies*. Modern methods set in force by these tremendous agencies are reflected in practically every section of the industrial field. Business that once crept around like an ancient on pussy feet, behind closed doors, with the gas turned down low; business that once carried on with a minimum of conversation in whispers, now stalks abroad jaunty and confident, proud of the plant, proud of the product and anxious that as great a number as possible shall become familiar with what is going on and in what manner this share of the world's work is accomplished.

THE sacred atmosphere of silence, of awe, of reverence, of secrecy; also the cobwebs, the verdigris, the dust and the precious mummy linens have disappeared before a steady and increasing blast of fresh air and sunshine as typified by the modern trend to gain the confidence of the public, either in the mass or in specially selected sections.

BASED to some extent on the urge for imitation which afflicts organizations as freely as it afflicts individuals, but based to a greater extent on the inherent merits of the system, a greater number of organizations are employing technical publicity directors, or delegating duties which come under this heading to an important member of the existing group or staff. The title bestowed on the incumbent of the office may read Director of Public Relations or simply Advertising Manager, but his duties fall within well recognized limits. His entire effort is devoted to placing the name of his company, its personnel and its products before the public in a favorable light through advertising and publicity. These men are specialists. As a rule, then, good men, suitably trained, are assigned a definite problem, in the details of their companies' new development and results appear soon in the shape of increased dividends.

¶ Changes in Steel

STATISTICS for United States and Canada recently compiled by the Steel Founders Society of America, New York, seem to indicate that buyers of steel castings move from the alloy variety to the plain carbon type during periods of depression. The proportion of alloy steel castings to entire output dropped from 13.5 per cent in 1929 to 10.1 per cent in 1930, while the output of carbon steel spread from 85.7 to 89.9 per cent of the entire output.

AS NATURALLY would be expected, total production of steel castings declined in 1930, the figures being 1,183,599 against 1,729,791 tons in 1929. Alloy steel castings production dropped from 252,692 tons in 1929 to 120,537 tons in 1930. The yearly capacity of all steel foundries in 1930 was given as 2,432,270 tons and the normal number of employes 67,033.

LITTLE change was noted in the relative positions of different types of melting mediums used in the steel foundry. Production of open-hearth steel was 67.8 per cent of the total in 1930 against 66.1 per cent the previous year. Electric furnaces made 31.3 per cent of the total output in 1930 against 31.7 per cent in 1929 and the convertor dropped from 2.2 per cent in 1929 to 1.9 per cent during the past year.

Comings and Goings of Foundrymen

Men of the Industry, Whose Activities Are Making Foundry History

EDMUND WAECHTER has become metallurgical engineer, American Hammered Piston Ring Co., a subsidiary of the Bartlett-Hayward Co., Baltimore. Mr. Waechter was born June 28, 1893 and received his education at Harvard university and the Massachusetts Institute of Technology. He received the degree of bachelor of science from the former and bachelor of science in metallurgical engineering from the latter. Following graduation he became connected with the Standard Tool Co., Cleveland, where he had charge of the metallurgical, chemical and testing laboratories and heat treatment department. From that time until 1922 he was melter on the electric furnace, Crucible Steel Casting Co., Cleveland; metallurgist and chemist, Carnegie Steel Co., Youngstown, O.; metallurgical engineer, Cleveland Hardware Co., Cleveland; and works manager and treasurer, Baker-Waechter Co., Cleveland. From 1922 to 1924 Mr. Waechter was metallurgical engineer, Brown & Sharpe Mfg. Co., Providence, R. I.; from 1924 to 1926, metallurgical engineer, General Chemical Co., New York; 1927 to 1929, general superintendent, Illinois Foundry Co., Springfield, Ill.; and during 1929 and 1930, he was connected with the National Bronze & Aluminum Foundry Co., as metallurgical engineer and assistant to the manager.

George C. McCormick, chief engineer, General Alloys Co., Boston, and Champaign, Ill., has been elected a vice-president.

F. Hugh Morehead, chief engineer, Walworth Co., Boston, has been appointed vice president in charge of engineering.

Daniel M. Jones, recently has become associated with the Ludlow Valve Mfg. Co., Troy, N. Y., as foreman of the brass foundry.

H. G. Chase, whose appointment as sales manager, Standard Alloy Co., Cleveland was noted in the July 1 issue of THE FOUNDRY, also has been appointed vice-president.

E. E. Griest, formerly general superintendent, Chicago Railway Equipment Co., Chicago, recently has been appointed vice-president in charge of manufacture.

Donald J. Dalton, president, **E. N. Roth,** vice president, **A. E. Morgan,** treasurer, **Theodore C. Fraser,** secretary, and **A. D. Bruce,** recently were re-elected directors of Dalton Foundries Inc., Warsaw, Ind. Other officers are: **A. F. Morgan,** general manager and **Clarke S. Brenneman,** assistant secretary.

Leslie C. Haswell, for 24 years purchasing agent for the Chapman Valve Co., Indian Orchard, Mass., has resigned. **Frank E. Phillips** has been promoted to purchasing agent and **Harold F. Wood** has been named personnel manager, succeeding **E. Edward Armstrong,** whose resignation became effective Aug. 1.

Charles E. Williams, recently elected junior vice president of the Institute of British Foundrymen, was born in 1866. He was educated at Manor House school, Clapham, London, the

Charles E. Williams

Leys school, Cambridge, and the South Wales University college, which he entered in 1883 as first student. In 1884 Mr. Williams joined the firm of John Williams & Sons, and he became manager of the Globe Foundry & Engineering Works, Cardiff, in 1887. The Globe foundry was incorporated with John Williams & Sons (Cardiff), Ltd., on the formation of that company in 1899, and still forms an important part of that company's activities. Mr. Williams is chairman of John Williams & Sons (Cardiff), Ltd., of Williams (Barry), Ltd., and of Emery Brothers, Ltd., Birmingham. He is director of the Principality Building society, Cardiff, and honorary treasurer of the Blind institute, Cardiff. He was president of the Cardiff & District Master Ironfounders' association for 22 years. That organization in recognition of his services presented him with his portrait in oils, at a dinner given in his honor, Christmas, 1920.

Charles D. MacGillivray recently was elected secretary, Baldwin Locomotive Works, Philadelphia, to succeed the late Arthur L. Church. **J. Harrison Kerst** was elected assistant secretary. They also were elected secretary and assistant secretary, respectively, of two Baldwin subsidiaries, Standard Steel Works Co., and Baldwin-Southwark Corp.

A. H. Landwehr, president, Holland Furnace Co., Holland, Mich., has been elected chairman of the board to succeed the late C. M. McLean. Mr. Landwehr is succeeded by his brother, **C. H. Landwehr,** formerly vice-president and general manager. **E. G. Landwehr** has been elected first vice-president, and **J. P. Kolla,** second vice-president.

Washington Founders Elect Officers

Washington Foundrymen's club installed the following newly elected officers at a meeting held in the Elk's club, Seattle, Wash., July 14: Rex L. Alexander, Olympic Steel Works, Seattle, president; D. Olson, Atlas Foundry & Machine Co., Tacoma, vice-president; Frank Jensen, Star Foundry Co., Seattle, treasurer; and Edward C. Gustin, Western Foundry Sand Co., Seattle, secretary. The board of trustees for 1931-32 consists of the following men: J. P. Jensen, Prescott Co., Seattle; James K. Paul, Troyer Fox Co., Seattle; Lawrence Schorie, Pacific Foundry Co., Tacoma; and Earl Mackie, Washington Stove Works, Everett. The new board will be under the chairmanship of the new president.

Makes Appointments

J. S. Tritle, vice-president and general manager, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has appointed T. J. Pace assistant to the vice-president. Mr. Pace will be in charge of market planning and research analysis. Other appointments include M. B. Lambert, sales manager in charge of transportation department; O. F. Stroman, sales manager in charge of industrial department; and R. A. Neal, sales manager in charge of central station department.

Porter Hurd, 516 Packard building, Philadelphia, has been appointed representative in Eastern Pennsylvania, Southern New Jersey, Delaware and Maryland for the products of the Illinois Testing Laboratories Inc., 141 West Austin avenue, Chicago.

OBITUARY

George A. Newman, secretary, Syracuse Chilled Plow Co., Syracuse, N. Y., died recently.

Henry J. Niemann, a director of the Enterprise Foundry Co., San Francisco, died recently.

Peter M. Boeck, formerly superintendent, Challenge Machinery Co., Grand Haven, Mich., died recently.

John A. Howard, for many years chief engineer, American Radiator Co., New York, died recently in that city. He was 59 years old.

Sherwood M. Chase, 65 years old, vice president and general manager, Chase Foundry & Mfg. Co., Columbus, O., died July 20.

Charles S. Barry, 56, secretary-treasurer, Murray Co., Dallas, Tex., manufacturer of cotton ginning machinery, died recently.

Daniel B. Moore, 53, who retired in 1930 as plant superintendent, Kewanee Boiler Corp., Kewanee, Ill., died recently.

Warren J. Davis, 75, former president, J. I. Case Co., Racine, Wis., died July 11 at New York. He resigned the presidency in 1924 and served as chairman until February, 1926.

Truman P. Gaylord, 60, vice president, Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., died July 5 in Shelby, Mich., his boyhood home, where he had been visiting his mother.

John S. Armour, sales manager, Campbell-Hausfeld Co., Harrison, O., died July 6 at the Good Samaritan hospital, Cincinnati. Mr. Armour originally was connected with the Jas. H. Mathews Co., Pittsburgh, and joined the Campbell organization in 1918. He had complete charge of the melting furnace department.

Walter F. Walker, founder and president, American Skein & Foundry Co., Racine, Wis., died at Chicago, July 22. Born in Dundee, Ill., Dec. 6, 1871, he established the business in Racine in 1905 to manufacture wagon skeins. With the decline of the wagon industry, the company turned to other products, including lifting jacks and other gray iron products.

Publishes Yearbook

The American Standards association, New York, recently published its *Yearbook* for 1931 which reviews the work of the association during the past year, gives a list of the various standards which have been approved and those which are being studied, etc. Up to January, 1931, the association has approved 181 standards and 179 incompleted projects have an official status before the association. During 1930, 46 standards were approved of which 19 were new and 27 were revisions of previous standards. Officers of the association are Bancroft Gherardi, American Telephone & Telegraph Co., New York, president Cloyd Chapman, New York, vice president and P. G. Agnew, New York, secretary.

Conducts Tests on Pipe and Fittings

Tests on drain pipe and special castings have been in progress for the past several years by the sectional committee of the American Standards association on specifications for drain pipe and special castings. Much valuable information has been collected and will be used in revision of existing specifications. Tests are being carried out at the University of Illinois under the supervision of Prof. M. L. Enger; at Iowa State college under the direction of W. J. Schlick; at Cornell university by Prof. E. W. Schoder; at the American Cast Iron Pipe Co., Birmingham, Ala., by S. R. Church; and by the Birmingham Water Co., by E. O. Sweet. Tests are being conducted on strength, trench load, friction loss with varying designs, organic coatings and linings, and cement and inorganic linings.

Gives Iron Statistics

American Iron & Steel institute, 75 West street, New York, recently has issued its semi-annual report on the production of pig iron and ferroalloys in the United States during the first half of 1931. According to the report, the same period, the production of those commodities was below that of the same period in 1930. Production of pig iron for the first half of 1931 was 11,165,389 gross tons as compared to 18,055,348 gross tons in the same period in 1930. Production of all varieties of ferroalloys also fell off from 415,262 tons in 1930 to 268,388 tons in 1931. Both foundry and malleable pig iron production decreased, the former from 1,970,501 tons to 1,245,642 tons and the latter from 984,614 tons to 517,611 tons. A total of 2,304,441 tons of pig iron was made for sale in the first half of 1931. Total ferroalloys made for sale was 211,517 tons. Tonnage of merchant pig iron produced was 1,024,662 gross tons, while 404,517 tons of malleable pig iron was made for sale. Production of charcoal iron decreased from 52,232 gross tons to 43,203 gross tons.

Faked Foundry Facts

A Header

Celebrates 50 Years

Fay & Scott Dexter, Me., manufacturer of a wide variety of special machine tools, commemorates the fiftieth anniversary of its founding in an attractive booklet in gold and white containing many interesting features and the pictures of those responsible for the past and present success of the enterprise. Tribute to the inventive genius of the founder, Norman H. Fay is paid in a line from Emerson under a reproduction of one of the late Mr. Fay's photographs on an inside page "An institution is the lengthened shadow of one man." The company points with pride to the fact that during the 50 years of its existence it has had no labor trouble. Executive officers of the company at present include: President W. L. Fay, son of the founder, vice president P. S. Plouff, treasurer W. R. Spencer, secretary Myrtle E. Leighton.

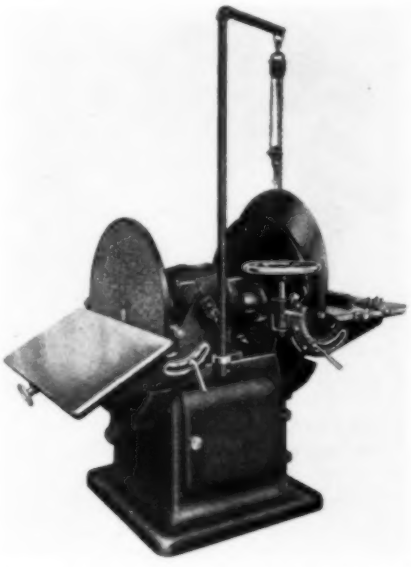
Issues Seventh Bulletin

Gray Iron institute, Terminal Tower building, Cleveland, has issued the seventh of its series of technical bulletins. The first article is entitled, "An Exposure of Modern Welding Fiction," and points out incorrect information that is being circulated by some companies on the properties of castings. Another section of the series of articles dealing with cupola practice also is presented. That section is devoted to cupola slags. Foundry sands and patents also are discussed. The bulletin is the first of the series of bulletins to be contained in volume 2, a new folder being enclosed with the bulletin.

Chain Belt Co., West Milwaukee, Wis., is building an addition 89 x 104 feet, to be devoted to engineering, testing and experimental work. The building will be a one and 2-story, brick and steel structure.

Sander Is Equipped with Special Attachments

Oliver Machinery Co., Grand Rapids, Mich., recently introduced a large size, motor shaft type, double disk sander for pattern shops. The machine carries two, 37-inch disks and is provided with devices for duplicating work and for circular sanding operations. A special fence for sanding duplicate pieces to size and to various angles is supplied as regular equipment. The circular sanding attachment consists of a metal plate equipped with a tongue to fit the slot in the table. That permits the use of the entire surface of the disk for circular sanding. The plate has a series of staggered holes



Duplicating Work May Be Performed on This Machine

to receive the center pin so that any diameter, within the capacity of the machine, may be sanded.

Hoods surround the disks for safety and for carrying the dust to the exhaust. A hoist is supplied with the machine and is made an integral part to facilitate changing or mounting disks. Abrasive sheets are cemented to the metal disks and are replaced easily. The unit is driven by a 7½ horsepower motor which is equipped with roller bearings and revolves at 900 revolutions per minute. The accompanying illustration shows one of the new machines.

Increase Adaptability of Molding Machine

A portable, jolt, rollover, molding machine, manufactured by the Arcade Mfg. Co., Freeport, Ill. and formerly used to a large extent for coremaking, has been redesigned to give it greater molding adaptability. Table height has been lowered to 25½ inches, jolting is controlled by a knee valve and the draw mechanism is equipped with bronze bushings that are replaceable easily. The table is cast in one piece with the rollover frame. The rollover table casting is of steel and is locked securely to the piston for jolting. Vibrator and blow-gun are standard equipment on this piece of apparatus. Dimensions of the machine include the following: Jolt cylinder diameter, 3 inches; table, 14 x 14 inches; draw, 6 inches; distance from floor to table, 25½ inches; wheel diameter, 9 inches; equalizer spacing, 11¾ inches; equalizer length, 12 inches; and net weight, 545 pounds. The molding machine is shown in the accompanying illustration.

Table Is Cast in One Piece While the Rollover Table Casting, Which Is of Steel, Is Locked Securely to the Rollover Frame

Sand Handling Machine Breaks-up Used Sand

George Haiss Mfg. Co., 141st street and Canal place, New York, has introduced a new type sand handling unit for use in foundries. The unit is of the portable, bucket-loader type and may be used for loading used sand upon conveyors or for handling new sand in the storage yard. The unit consists of a series of picks that rotate at the bottom of a bucket conveyor and are claimed to break up any lumps of sand. The bucket conveyor is tilted upward at an angle of approximately 45 degrees and delivers the sand to a short chute through which it falls upon a horizontal belt conveyor to be delivered to the desired location. When the sand is being discharged on the short belt conveyor, it passes over a magnetic pulley which separates the scrap from the sand. The unit is gas-engine driven.

The unit has capacities as large as 2 cubic yards per minute. The machine, which may be operated by one man, cleans up and piles the sand as it travels along. The transmission of the unit is specially designed and consists of a gear-set enclosed and running in oil. The slow-speed worm drive is designed to permit crowding the machine into a pile at the steady rate of 3 feet per minute. The accompanying illustration shows a machine equipped with a magnetic separator but the company also builds smaller models without the magnetic separator.

Rotating Picks at the Bottom of the Bucket Conveyor Break-up Any Lumps in the Sand

Interchangeability Is Blowpipe Feature

Linde Air Products Co., 30 East Forty-second street, New York, recently has added a cutting blowpipe and cutting attachment to its new line of medium-pressure apparatus of the detachable valve body design. The new cutting apparatus includes a cutting blowpipe and a cutting attachment.

Those two pieces of cutting apparatus, with corresponding types of welding blowpipes, may be used interchangeably with the same detachable valve body. With the detachable valve body, the operator can change easily and quickly from a full size welding blowpipe to a smaller welding blowpipe, to a full size cutting blowpipe, or to a cutting attachment without detaching the hose or hose connections.

Locking device for connecting the detachable valve body to any of the

The Detachable Valve Makes the Blowpipe Convertable

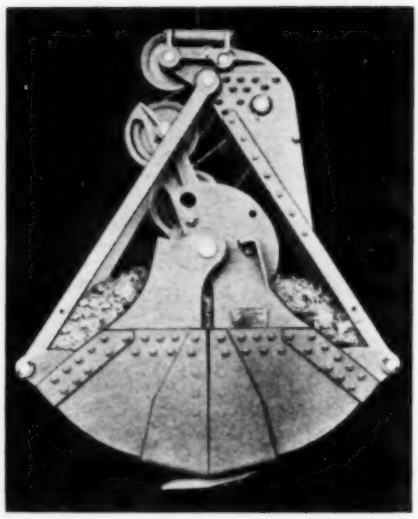
blowpipe handles consists of a locking bolt and wedge-shaped locking screw. The locking screw is operated by turning a ring and draws the detachable valve body and blowpipe handle together making a gas-tight joint.

The blowpipe is of light but sturdy construction to withstand the hard usage. It is supplied as standard with 4 cutting nozzles and a 75-degree angle head. If required, a 90-degree angle head can be supplied. Steel and wrought iron up to 12 inches in thickness may be cut with this blowpipe.

The cutting attachment is of the single joint design and attaches directly to the valve body. It will cut metal up to 2 inches in thickness. Because of its small size, only 11 inches overall, it may be carried conveniently in the pocket of the operator when not in use. Advantages of design and construction embodied in the full size corresponding type cutting blowpipe are incorporated in this cutting attachment.

Introduces New Type of Clamshell Bucket

G. H. Williams Co., Erie, Pa., has introduced a new type clamshell bucket applicable to foundry work. Features of the new unit include speed, low maintenance costs, high digging and closing power and low wear on sheaves, shafts, bearings and cable. It is claimed that because of the increased digging power, fewer parts of closing line are necessary. The tandem-sheave feature provides straight



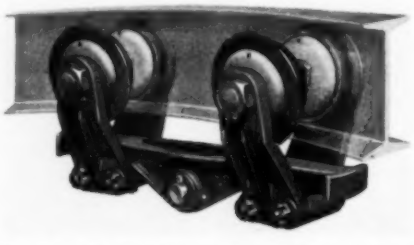
Additional Closing Leverage Is Gained by Use of Extended Corner Brackets

cable leads and also tends to reduce wear.

Additional closing leverage is gained by extended corner brackets projecting beyond the backs of the scoops. A narrow cast steel head provides rigid resistance to twisting strains. A new type of extra long roller guards and large transverse rollers protect the cable. Each corner pin has a T-shaped head, which fits into a slot in the corner bracket to prevent turning of the pin as the bucket opens and closes and to minimize the wear on the corner bar bushings.

New Trolley Is Equipped With Ball Bearings

Richards-Wilcox Mfg. Co., Aurora, Ill., recently has placed on the market a new style ball bearing trolley for use with I-beam tracks. The units of the trolley, shown in the accompanying illustration, are connected so that they are free to swivel when going around curves. It is claimed that this feature allows but little more energy to be consumed in rounding curves than on the straight track. The trolley has a long wheel base which is said to give smoothness of travel. Ball bearings are used in the wheels and the balls are protected with felt seal washers. That feature is claimed to keep the dust and dirt out of the bearings and to add life to

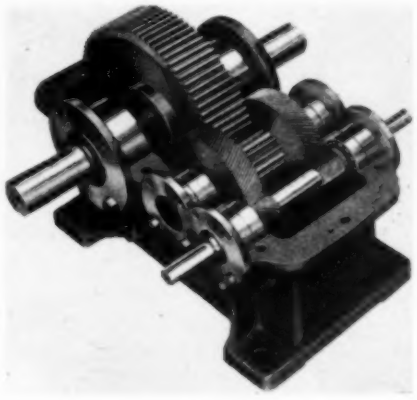


Trolley Is Designed So That the Bar Cannot Become Detached from the Wheel Unit

the trolley. The body of the wheel is made of dense, strong, gray iron with chilled tread. Each trolley is built adjustable to fit four sizes of track and is made for any size I-beam up to 12 inches.

Reducers Are Designed for Electric Motors

W. A. Jones Foundry & Machine Co., 4401 West Roosevelt road, Chicago, has introduced a new series of speed reducers for electric motors with capacities up to 18 horsepower and reduction ratios from 12 to 48 to 1. The smallest reducer of the new series is 20 5/16 inches long and 14¼ inches high. The base measures 10¼ inches wide. The reducers have high and low speed



Reducers Are Available Up to 18 Horsepower and in Reduction Ratios from 12 to 48 to 1

shaft extensions on both sides and two shaft guards are provided.

The accompanying illustration shows a unit of the new series. The high speed pinion and shaft are made of chrome-nickel steel with the pinion forged integral with the shaft. Because of the extension of the high speed shaft on both sides of the unit, location of the motor is selective. The low speed gear is a high carbon steel casting. The low speed shaft is a high carbon steel forging and is supplied with a double shaft projection so that the unit may be connected from either side to the shaft of the driven machine.

Two shaft guards are of thin drawn steel tubing and are used to enclose the high speed shaft extension on one side and the low speed shaft extension on the other. The unit is equipped with roller bearings which are capable of taking both radial and thrust loads simultaneously. Housings are made of high-grade, close-grained, gray cast iron and consist of two main sections flanged and arranged for bolting together on a horizontal plane passing through the center of the bearings. Each machine is equipped with large inspection plugs in the hood. Those plugs also are used for admission of oil. Eye-bolts, drain plugs and oil level riser are standard equipment.

What Others Are Thinking

Abstracts Selected from European Foundry Literature

Atmosphere Exerts Influence

Porosities of Bronzes, (Porosities des Bronzes), by G. Antoine, *La Fonderie Belge*, Liege April, 1931.

It is admitted generally that the atmosphere of the furnace has considerable influence on the porosity of bronzes. Oxygen forms an oxide with pure copper which is soluble in the metal, forming a eutectic. Beyond a certain quantity of oxide, the metal is fragile. In carbon monoxide, copper becomes fragile after solidification if it has been maintained in the atmosphere of CO for sufficient time. While opinions concerning solubility of various gases in copper are divided, it is agreed generally that gases are soluble, but that they escape during solidification.

A neutral, or a slightly oxidizing furnace atmosphere is preferable to a reducing atmosphere. The crucible furnace is preferable to an open-flame furnace. Experiments have been made in a cupola, with a special coke, which have indicated that, notwithstanding a strong oxidation, excellent bronzes could be obtained.

Steel Castings Crack

Cracks in Steel Castings When Hot, (Les Criques a Chaud dans l'Acier moule), by A. Hencks, *La Revue de Fonderie Moderne*, Paris, May 10 and May 25, 1931.

Cracks in steel castings when hot present three characteristics: They are oxidized; the walls of the crack are rough; and their aspect is similar to that obtained when pasty material is torn apart. These characteristics indicate that the cracks have been formed at a high temperature. Korber and Schitzkowski showed, in 1927, that they take place at about 1300 degrees Cent. (2372 degrees Fahr.) Among important factors bearing on the time available before reaching the critical temperature are: Temperature at which the metal is poured; material of the mold; the speed of pouring; number and location of heads, etc.

The facility with which cracks can occur is explained by the lack of strength of the metal immediately after solidification, with strong contraction during the interval of solidification. A crack formed under these conditions, when the metal is hot, can be the starting point for cold cracks. In a casting presenting walls of unequal thicknesses, the location, size and distribution of heads and risers are important.

Contraction of steel varies with the temperature at which the steel is poured. For castings presenting unequal thicknesses it is believed best to pour the metal cold, but for a casting of uniform thickness the reverse appears to be true. Manganese steel containing from 12 to 14 per cent manganese should not be poured too hot. Generally speaking, carbon, phosphorus and sulphur tend to decrease contraction, while silicon and manganese increase it.

There are many methods to avoid or reduce the possibility of cracks. Among the principal are: Use of chills, a slight modification in the section or profile of the casting, the choice of various materials for different parts of the mold, ramming certain parts of the mold less than others, using green sand instead of dry sand, breaking up certain parts of the mold during solidification.

Developments in the Foundry

Recent Developments in Cast Iron and Foundry Practice in Great Britain, by J. G. Pearce, *Foundry Trade Journal*, London, June 25 and July 9, 1931.

The title of this article is slightly misleading in that it is a resume of the accomplishments of the British Cast Iron Research association since its inception. The article describes the work on determining molding sands properties in Great Britain and outlines the work being carried out at the present time.

Two kinds of cupolas developed by the association are described. One is the *soft blast* type and the other the *balanced blast* cupola. The cupola first mentioned is characterized by an ample height from tuyeres to charging door, a large wind belt, low air pressure, and a single row of rectangular tuyeres approximately twice as wide and they are deep and flared toward the inside of the cupola. Yield is not as high as in the rapid melting type but improved quality of the melt is claimed.

The balanced blast type is supplied with a row of main tuyeres and two or more rows of auxiliary tuyeres. Tuyeres are in and fed by the same wind belt. A feature of the type cupola is that the main tuyeres are controlled by finely adjustable screw valves which regulate the admitted air. Tuyere apertures between the valves and the cupola are so designed that, although the annular stream of air passing the valves is at high velocity, the impinging effect of the air on the coke is reduced to produce a softer blast. Many claims are made for this type cupola including high iron to coke ratios, hot metal, less patching, increased melting rate, reduced sulphur pick-up, and large coke savings.

The association also has developed a series of high silicon irons having growth and scale resisting properties. The irons contain 5 per cent and upward of silicon but the general run of that type iron manufactured runs from 5 to 7 per cent. Work also has been done on propounding the germ theory of cast iron. This theory is a working hypothesis explaining the reason for two irons of the same or approximately the same composition having different structures.

Stability Is Studied

Dimensional Stability of Heat Treated Aluminum Alloys, by J. D. Grogan and D. Clayton, *Metal Industry*, London, April 10, 1931.

This investigation was carried out under the direction of the alloys subcommittee of the aeronautical research committee for the department of scientific and industrial research. The investigation covered reports of serious secular changes occurring in light alloys during storage and to dimensional changes occurring when heat treated alloys are machined.

Alloys investigated included cast and wrought *Y* alloy, wrought duralumin and chill and sand cast 2*L*5 alloy. Cast-material was in the form of 1-inch diameter bars cast in metal molds, except two test pieces of the latter alloy which were cast in sand.

Results of the research showed that no secular changese were detected in heat treated aluminum alloys examined after the normal age hardeniing process was complete. Considerable dimensional changes occur when material quenched in cold water is machined. Changes are greatest in *Y* alloys, less in duralumin and smaller in the copper-silicon alloy. The central length of a heat treated cylinder contracts less than the peripheral length when concentric rings are machined from the middle portion of the length of the test piece, consequently the ends become convex.

When a narrow groove is cut in the center of the test piece and is widened subsequently, complicated dimensional changes occur. The first cut produces a large change both in central and peripheral length. Subsequent widening of the cut produces small changes in the central length which reverses in direction. Smaller changes of uniform amounts, smaller than the first, occur in the prepheral length. Quenching in cold oil reduces those changes which occur in machining when the specimen of *Y* alloy and duralumin are quenched in cold water. Those were the only alloys investigated in that manner. Quenching in boiling water reduces the changes to relatively small proportions.

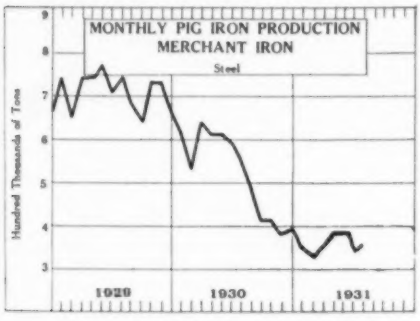
Tempering subsequent to quenching in cold water reduces dimensional changes in 2*L*5 alloy but increases them to a small extent in the copper-silicon alloy. Those dimensional changes do not appear in annealed material. Brinell hardness of cylinders 5 inches long and 3 inches in diamter of those alloys after quenching in cold water attains a value at least equal to that found in cylinders of much smaller masses. Cylinders of *Y* alloy and duralumin of the same dimensions are hardened satisfactorily by quenching in boiling water.

Trade Trends in Tabloid

INDUSTRIAL activity changed but little during the early part of August. Gains in the textile and leather producing industries were offset by downward trends in other major industries, such as automobile and steel. An especially bright spot in the situation is the rather large volume of public work which is beginning to get under way and probably will be in full swing during the fall and winter.

—T—T—

The first of the month found foundry operations at the lowest point of the year, due in part to seasonal influences. Reports indicate that some improvement is underway and that an



upward trend is expected to continue throughout the fall.

—T—T—

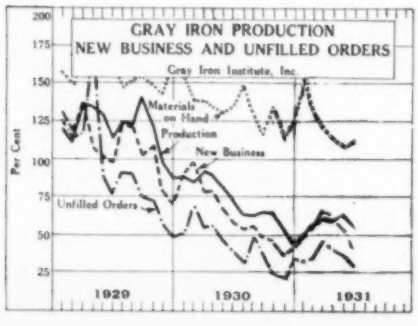
Despite a few foundries resuming part of full time operations following vacation shut-downs, the average of operations in the Chicago territory is from 20 to 25 per cent. Reductions late in July among western Michigan automotive foundries affected the August rate. Three or four plants are busy producing castings for a new low priced car. Farm implement foundries are not expected to reach anything like satisfactory production until in September or October, but a few jobbing shops have increased the production rate on implement business.

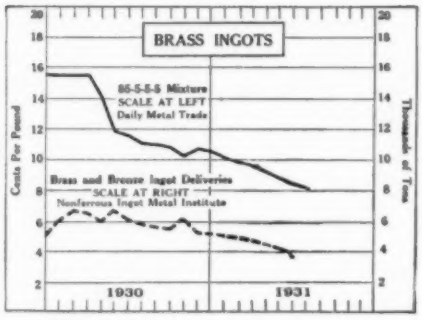
—T—T—

With one large manufacturer out of production and the output of numerous others curtailed, August automobile production probably will be below the July output, which totaled approximately 200,000 units.

—T—T—

According to a report of the Steel





Founders Society of America, 88.9 per cent of the membership reporting are booking orders at a rate below 50 per cent of capacity. Report of present operations shows 90.2 per cent below 50 per cent of capacity; 6.6 per cent from 50 to 69 per cent and 3.2 per cent from 70 to 89 per cent. The business outlook is good according to 1.7 per cent, while 51.7 report fair and 46.6 poor.

—T—T—

Foundry operations in the Pittsburgh district settled to the year's lowest level in July. Gray iron foundries were averaging about 20 per cent, while radiator and sanitary producers remained moderately above the average jobbing shop. Steel foundry operations averaged around 25 to 35 per cent.

—T—T—

Malleable castings orders in June totaled 22,529 tons compared with 28,208 tons in May. Production for June

RAW MATERIAL PRICES
Aug. 6, 1931

Iron	
No. 2 foundry, Valley	$17.00
No. 2 Southern, Birmingham	12.00 to 13.00
No. 2 foundry, Chicago	17.50
No. 2 foundry, Buffalo	17.00
Basic, Valley	17.00
Basic, Buffalo	16.50 to 17.00
Malleable, Chicago	17.50
Malleable, Buffalo	17.50
Coke	
Connellsville beehive coke	$3.25 to 4.50
Wise county beehive coke	4.25 to 5.00
Detroit by-product coke	8.00
Scrap	
Heavy melting steel, Valley	$10.50 to 11.00
Heavy melting steel, Pitts.	10.50 to 11.00
Heavy melting steel, Chicago	8.50 to 9.00
Stove plate, Buffalo	7.75 to 8.00
Stove plate, Chicago	7.00 to 7.50
No. 1 cast, New York	7.00 to 7.50
No. 1 cast, Chicago	8.75 to 9.25
No. 1 cast, Philadelphia	11.50 to 12.50
No. 1 cast, Pittsburgh	10.00 to 10.50
No. 1 cast, Birmingham	9.00 to 10.00
Car wheels, iron, Pittsburgh	11.00 to 11.50
Car wheels, iron, Chicago	10.00 to 10.50
Railroad malleable, Chicago	8.50 to 9.00
Agricultural mal., Chicago	8.25 to 8.75
Malleable, Buffalo	10.00 to 10.50
Nonferrous Metals	**Cents per pound**
Casting copper, refinery	7.40
Straits tin	24.37½
Aluminum, No. 12, producers	22.00
Aluminum, No. 12, remelt	9.00 to 10.50
Lead, New York	4.40
Antimony, New York	6.62½
Nickel, electro	35.00
Zinc, East St. Louis, Ill.	3.85

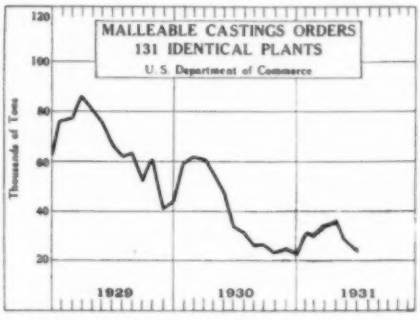
was 23,712 tons against 31,344 tons in May, according to the department of commerce.

—T—T—

Revenue freight car loadings for the week ended July 25 totaled 741,752 cars, according to the American Railway association. The total represents a decrease of 15,803 cars over the previous week.

—T—T—

Tonnage of gray iron castings produced in the Philadelphia district in June, according to the industrial research department of the University of Pennsylvania, was 2.2 per cent in



excess of the output for May. Malleable production in the district declined 8.9 per cent in June and the output of steel castings fell off 2.9 per cent.

—T—T—

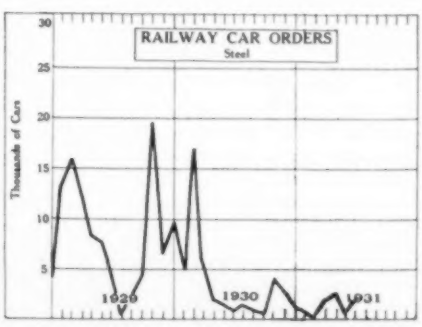
Foundry operations in the St. Louis district average around 25 per cent of capacity. The rate is expected to be improved after the middle of the month when several shops that have been down since the first of July are scheduled to resume operations.

—T—T—

Cast iron pressure pipe shops in the Birmingham district are receiving orders which warrant 50 per cent operations. Jobbing shops are operating at a low percentage.

—T—T—

Average New York prices of nonferrous metals during July, according to *Daily Metal Trade*, were as follows: Casting copper, 7.736c; electrolytic copper, 7.937c; Straits tin, 24.963c; lead, 4.4c; antimony, 6.822c; aluminum, 98-99, 22.9c. Zinc averaged 3.902c, East St. Louis, Ill.



What the Foundries Are Doing

Reflecting the Activities of Gray Iron, Malleable, Steel and Brass Shops

U. S. Brass Corp., 1276 East Fifty-fifth street, Cleveland, recently has added equipment to its foundry.

Texas Machine & Foundry Co., San Antonio, Tex., has acquired property at 1407 Hoefgen street for a new shop.

Perfection Die Casting Corp., 412 Lakeside avenue, Cleveland, has discontinued business and the equipment has been sold.

Foundry of the Wayne Agricultural Works, Goldsboro, N. C., recently was damaged by fire to the extent of $100,000.

Guelph Stove Co., York road, Guelph, Ont., is considering the erection of a plant addition. The new construction is estimated to cost $50,000.

Chicago Foundry Hardware Co., Elkhart, Ind., has been working at capacity for the past 5 or 6 weeks, according to reports. A night shift also is employed.

Old Dominion Foundry Works, Norfolk, Va., has been incorporated with $40,000 capital by J. H. Privott, 110 East Indian River road.

Jenkins Bros. Ltd., 617 St. Remi street west, Montreal, has begun the construction of the foundry recently noted. Production is not expected to begin until the new year. (Noted May 1.)

Modern Foundry Co., Pont Viau, Que., has been organized and has taken over the plant formerly occupied by the Viau Foundry Co. M. Ellison is president and manager of the new company.

Ft. Worth Die Casting Co., Fort Worth, Tex., has leased a building at 2233 Dallas pike, for the manufacture of nonferrous castings. J. W. Allen is manager.

Holloware Foundry, Wapakoneta, O., may be reopened pending proposed marketing arrangements with outside interests. Plant would employ 50. George Trautman is manager.

Sheets Construction Co. Inc., Fort Wayne, Ind., has been incorporated with $50,000 capital by W. A. Sheets, C. E. Carter, and J. W. Snyder, to do metal and wood work, and foundry work.

Detroit Ornamental Foundry Co., Detroit, has been incorporated with $20,000 capital by Martin A. Miller, 1971 Guoin street, to manufacture metal castings.

K. & F. Brass Foundry, Orrville, O., has received a large order for brass castings from a machine shop in Akron, O., which will keep the foundry busy for several months.

Sparta Foundry Co., Sparta, Mich., has secured several large orders and will increase production Aug. 15. The company manufactures piston ring castings exclusively and has a daily capacity of 750,000.

Service Foundry Co., 1152 South Peters street, New Orleans, has let the contract to the Pittman Construction Co., to erect a new plant, 48 x 175 feet, to replace that recently burned. (Noted Aug. 1.)

Shank Foundries Inc., has been incorporated by G. L. Shank, E. H. Barnning and R. E. Hamilton, Elkhart, Ind., to do general foundry work. The company has secured the plant formerly occupied by the Akron Foundry Co., Akron, Ind., and operations are expected to start the latter part of August.

Kinite Corp., foot of East Park place, Milwaukee, has transferred its production of gray iron castings from its other plants and has concentrated its activities in that line to its plant at Fairmount, W. Va. That plant will manufacture gray iron castings exclusively. (Noted Aug. 1.)

St. Joseph Steel Alloys Co., St. Joseph, Mich., has been formed with a capitalization of $125,000 to take over the plant of the former St. Joseph Electric Steel Castings Co. The proposed industry would produce stainless steel castings. Frank Hatfield, purchaser of the St. Joseph Electric Steel Castings Co., is interested.

American Manganese Steel Co., Chicago, is reported to be negotiating with city officials of Montreal, Que., for the erection of a foundry and plant in that city. It is understood that $2,000,000 will be spent on the plant which will be located in the eastern section of the city, on the banks of the St. Lawrence river. Company officials deny the report, no plans having been made.

Viau Foundry, Pont Viau, Que., has transferred its activities from Pont Viau to the plant formerly occupied by the Laurie Engine Co. and more recently by Burnett & Crampton Ltd., Tansley street and Delorimier avenue, Montreal. Bruno Cote is president and manager. The name of the company also has been changed to the Riverside Foundry Co. Ltd.

Atlas Foundry has purchasd the plant and business of the Arthur Foundry, Sumit avenue and S. A. L. Railway, Charlotte, N. C., according to advice from L. J. Nolan of the former company. The company manufactures building, municipal and cotton mill castings and does general jobbing.

Tiffany Castings Co., Branch and Buchanan streets, St. Louis, has been organized by Zigman Chaplick, Chaplick Machine Works, Chicago, for the manufacture of smoking stands and household equipment. The new company occupies the plant formerly housing the Tiffany Aluminum Products Co. It is reported that the Chaplick Machine Works will be moved to St. Louis and consolidated with the Tiffany company.

Bound Brook Oil-less Bearing Co., Bound Brook, N. J., has formed a subsidiary company to be known as the Fischer Foundry Corp. The new company will occupy the foundry building now used by the Bound Brook company and will manufacture bronze and aluminum castings. Officers of the new company include W. F. Jennings, president; L. A. J. Fischer, vice president in charge of sales; C. J. G. Fischer, vice president in charge of production; G. O. Smalley, treasurer; H. O. Johnson, secretary and Loren Wood, counsel.

New Trade Publications

DIESEL ENGINES—Solid-injection, diesel engines made by the Ingersoll-Rand Co., New York, are illustrated in a booklet recently issued. General characteristics of stationary types and design features are discussed. Dependability, adaptability, economy of operation, and principle of operation are covered.

CAR SPOTTER — Illustrations in a book recently issued by H. W. Caldwell & Son Co., 2410 West Eighteenth street, Chicago, show design and typical applications of an electric, motor-drive, car spotter. The unit is of the capstan type driven through a speed reduction unit. Economies and convenience in its use are pointed out.

CASTING ALLOY—A bulletin recently issued by Apex Smelting Co., 2554 Fillmore street, Chicago, describes a new, high-strength, corrosion-resisting, aluminum alloy developed by the company. The alloy is recommended for architectural applications, cooking utensils, marine castings, and similar work in sand, die, or permanent mold castings.

GENERATOR UNITS—Small, electric-generator units and their applications are described in a recent, 12-page bulletin, Circular 1908, from Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa. Belt-driven generators, turbine-generator units, portable gas-engine-driven units, and electric service plants up to 15 kilowatts capacity are described and applications discussed.

FEEDER HEAD LIQUID—A recent folder from the Alpha-Lux Co., Inc., 192 Front street, New York, points out advantages of the use of the product which is placed on feeder heads as soon as the metal rises to the top. Attention is called to its clause for effectiveness in reducing heads by 50 per cent and in improving the structure of the castings.

ELECTRIC HOISTS—A new catalog of 48 pages has been issued by Wright Mfg. Co., Bridgeport, Conn. Complete description of electric hoists made by that company is included with dimensions, as well as other useful data. The hoists include hook and bolt suspension; plain, geared, and motor-driven trolleys; and drum and low-headroom types.

PIPING AND VALVES—A bulletin issued by Semet-Solvay Engineering Corp., 40 Rector street, New York, contains engineering specifications and illustrations of piping and valve equipment. The catalog is completely indexed, contains two tables of standards, presents diagrams of operating arrangements for gate valves, and offers suggestions for efficient planning of new piping. The information is arranged to aid engineers in specifying equipment for various installations.

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A classified list of advertisers according to products. ¶Index to advertisements give page number of any advertiser.

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ABRASIVES—Metallic

American Steel Abrasives Co., Galion, O.
Globe Steel Abrasive Co., Dept. F., Mansfield, O.
Patch-Wegner Co., Inc., Rutland, Vt.
Philadelphia Steel Abrasive Co., The, East of Lewis & Ashland Sts., Frankford, Philadelphia, Pa.
Pittsburgh Crushed Steel Co., Pittsburgh, Pa.
Steel Shot & Grit Co., Amesbury, Mass.
Steelblast Abrasives Co., Cleveland, O.

ACETYLENE DISSOLVED OR IN CYLINDERS

Linde Air Products Co., 30 E. 42nd St., New York City.

ACETYLENE GENERATING APPARATUS

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British Aluminium Co., Ltd., 122 E. 42nd St., New York City.

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ARCHITECTS—Industrial

Austin Co., The, 16112 Euclid Ave., Cleveland, O.

ARRESTORS & COLLECTORS—Dust—See Dust Arresting and Collecting Systems

BABBITT METAL

Ajax Metal Co., 46 Richmond St., Philadelphia, Pa.

BELLOWS—Molders

Osborn Mfg. Co., Inc., 5401 Hamilton Ave., Cleveland, O.
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Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh, Pa.

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Shanafelt Mfg. Co., Canton, O.
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BOXES (Tote)

Sterling Wheelbarrow Co., Milwaukee, Wis.

BRONZE—Manganese

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Osborn Mfg. Co., Inc., 5401 Hamilton Ave., Cleveland, O.

BRUSHES—Motor and Generator

General Electric Co., Schenectady, N. Y.
United States Graphite Co., The, Saginaw, Mich.

BUCKET CARRIERS—Pivoted

Milwaukee Electric Crane & Hoist Corp., Milwaukee, Wis.

BUCKETS

Penn Foundry & Mfg. Co., Reading, Pa.

BUCKETS—Clamshell, Dragline, Grab

Brosius, Edgar E., Inc., 19th St. & P. R. R., Sharpsburg P. O., Pittsburgh, Pa.
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Erie Steel Construction Co., Erie, Pa.

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Milwaukee Electric Crane & Hoist Corp., Milwaukee, Wis.

BUILDINGS—Foundry, Factory, Industrial

Austin Co., The, 16112 Euclid Ave., Cleveland, O.

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CARBIC

Linde Air Products Co., 30 E. 42nd St., New York City.

CARBIDE

Linde Air Products Co., 30 E. 42nd St., New York City.

CARS—Platform, Industrial Railway, Transfer, Narrow Gage

Foundry Equipment Co., The, 1831 Columbus Rd., Cleveland, O.
Penn Foundry & Mfg. Co., Reading, Pa.

CARS & LOCOMOTIVES—Industrial

Industrial Equipment Co., The, Minster, O.

CASE HARDENING—Compound

Pettinos, Geo. F., Inc., 1206 Locust St., Philadelphia, Pa.

CASTINGS (Heat Resistant)

Driver-Harris Co., Harrison, N. J.

CASTINGS—Nickel Chromium

Driver-Harris Co., Harrison, N. J.

CEMENT—High Temperature, Refractory

Alpha-Lux Co., Inc., 192 Front St., New York City.

CEMENT—Metallic

Shanafelt Mfg. Co., Canton, O.

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Pettinos, Geo. F., Inc., 1206 Locust St., Philadelphia, Pa.
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CHARGING EQUIPMENT—Air Furnace

Euclid Crane & Hoist Co., The, 1364 Chardon Rd., Euclid, Ohio.

CHROMIUM

Electro Metallurgical Sales Corp., 30 E. 42nd St., New York City.

COAL

Hanna Furnace Corp., The, Detroit, Mich.

COAL CRUSHERS and Pulverizers

Bartlett, C. O., & Snow Co., 6201 Harvard Ave., Cleveland, O.

COAL—ORE—ASH HANDLING MACHINERY

Bartlett, C. O., & Snow Co., 6201 Harvard Ave., Cleveland, O.
Harnischfeger Corp., 3800 National Ave., Milwaukee, Wis.
Louden Machinery Co., 183 Court St., Fairfield, Ia.
Milwaukee Electric Crane & Hoist Corp., Milwaukee, Wis.

COKE

Hanna Furnace Corp., The, Detroit, Mich.
Semet-Solvay Co., 61 Broadway, New York City.

CONTRACTORS—See Engineers, Architects, Contractors

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Bartlett, C. O., & Snow Co., 6201 Harvard Ave., Cleveland, O.
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Beardsley & Piper Co., The, 2541 N. Keeler Ave., Chicago, Ill.
Cleveland Electric Tramrail Div. of Cleveland Crane & Eng. Co., Wickliffe, O.
Louden Machinery Co., 183 Court St., Fairfield, Ia.
National Engineering Co., 549 W. Washington Blvd., Chicago.
Osborn Mfg. Co., Inc., 5401 Hamilton Ave., Cleveland, O.

CORE BINDERS

Corn Products Refining Co., 17 Battery Place., New York City.
Pennsylvania Lubricating Co., 34th & Smallman Sts., Pittsburgh.
Smith, Werner G., Co., 2191 W. 110th St., Cleveland, O.

CORE BREAKERS

Bartlett, C. O., & Snow Co., 6201 Harvard Ave., Cleveland, O.

CORE COMPOUNDS

Corn Products Refining Co., 17 Battery Place, New York City.
Lindsay-McMillan Co., 930 S. Water St., Milwaukee, Wis.
Pennsylvania Lubricating Co., 34th & Smallman Sts., Pittsburgh.
Pettinos, Geo. F., Inc., 1206 Locust St., Philadelphia, Pa.
Smith, Werner G., Co., 2191 W. 110th St., Cleveland, O.

CORE KNOCKOUT MACHINES

Beardsley & Piper Co., The, 2541 N. Keeler Ave., Chicago, Ill.

CORE MAKING MACHINES

Arcade Mfg. Co., Dept. D, Freeport, Ill.
Demmler, Wm., & Brothers, Kewanee, Ill.
Herman Pneumatic Machine Co., Union Bank Bldg., Pittsburgh.
International Molding Machine Co., 2616 W. 16th St., Chicago, Ill.
Osborn Mfg. Co., Inc., 5401 Hamilton Ave., Cleveland, O.
Tabor Mfg. Co., The, 6225 Tacony St., Philadelphia, Pa.

CORE OIL

Lindsay-McMillan Co., 930 S. Water St., Milwaukee, Wis.
Pennsylvania Lubricating Co., 34th & Smallman Sts., Pittsburgh.
Smith, Werner G., Co., 2191 W. 110th St., Cleveland, O.

CORE OVEN REPAIRS

Westhead, S., 3590 Antisdale Rd., Cleveland Heights, O.

CORE OVENS—See Ovens—Core-Mold

CORE RACKS

Foundry Equipment Co., The, 1831 Columbus Rd., Cleveland, O.
Truscon Steel Co. (Pressed Steel Div.), 6114 Truscon Ave., Cleveland, O.

CORE RODS

Franklin Core Rod & Gagger Co., Franklin, Pa.

CORE ROOM EQUIPMENT

Truscon Steel Co. (Pressed Steel Div.), 6114 Truscon Ave., Cleveland, O.

CORE SAND MIXERS

National Engineering Co., 549 W. Washington Blvd., Chicago, Ill.